NEW ENGLAND WATER WORKS ASSOCIATION.

ORGANIZED 1882.

Vol. XV. September, 1901. No. 5.

This Association, as a body, is not responsible for the statements or opinions of any of its members.

WATER WORKS STATISTICS FOR THE YEAR 1900, IN FORM ADOPTED BY THE NEW ENGLAND WATER WORKS ASSOCIATION.

COMPILED BY CHARLES W. SHERMAN, EDITOR, JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION.

In preparing a table of statistics for 1900, the Editor has attempted, —

First, to secure reports from all places publishing a summary of statistics in the form adopted by this Association, or a modification or abridgment thereof.

Second, to obtain statistics in manuscript on the blank forms furnished by the Association, from as many places as possible where summaries are not published in the annual reports.

Third, to compile as complete summaries as possible from such other reports as were accessible, and which contained sufficient data to render it worth while.

In these attempts he has succeeded as follows: —

1. Reports were secured from all places publishing summaries of which the Editor has knowledge.

2. Statistics in manuscript were obtained from the following places: Boston, Cambridge, Chelsea, Essex Junction, Nantucket, Nashua, Quincy, and Somerville; and the Editor takes this opportunity to express his thanks to the gentlemen through whom these data were secured. It is worthy of notice that in this list are two works owned by private water companies, — those at Nantucket and Nashua.

3. More or less complete statistics for twenty other places have

been compiled by the Editor from their annual reports, and the names of these places are printed in italics in the following tabulation.

Duty. — The duty of the pumps is computed by the following formula: —

$$\text{Duty} = \frac{\text{Gallons pumped (6)} \times 8.34 \text{ (lbs.)} \times 100 \times \text{dynamic head (8)}}{\text{Total fuel consumed (5)}}.$$

It therefore represents the *average* duty of all the pumps, when there are more than one.

New Column. — In Table V, Service Pipes, the Editor has added a new column, headed "Percentage of Taps Metered." The figures in this column have been obtained by dividing the total number of meters (column 26) by the total number of service taps in use (column 22); and while this method may not always give strictly accurate results, the percentages given are believed to be sufficiently near the truth for all practical purposes.

REFERENCES TO ADOPTION OF FORM OF SUMMARY AND TO COMPILATIONS OF STATISTICS.

The form employed for a summary of statistics was adopted by the Association at the fourth annual convention, June 18, 1885, following the recommendation of a committee consisting of Messrs. William R. Billings and R. C. P. Coggeshall. Their report, together with the ensuing discussion, is printed in the *Transactions* of this Association for the year 1885, pages 118–148. A later committee, consisting of Messrs. Desmond FitzGerald and Willard Kent, endorsed the form of summary and recommended that a large number of copies be printed for distribution; their report may be found in Volume VIII of the JOURNAL, page 9.

Compilations of statistics prepared in this form may be found as follows: —

YEAR.	JOURNAL.
1886	Vol. I, No. 4, p. 29
1887	Vol. II, No. 4, p. 28
1888 to 1892 inclusive	Vol. VII, p. 225
1893	Vol. IX, p. 127
1894	Vol. X, p. 131
1895–96	Vol. XII, p. 273
1897–99	Vol. XV, p. 65
1900	Vol. XV, p. 367

The various compilations include statistics for the following places and for the dates given: —

1. Albany, N. Y., 1900.*
2. Andover, Mass., 1900.*
3. Arlington, Mass., 1900.*
4. Atlantic City, N. J., 1898, 1900.
5. Attleboro, Mass., 1894–1900.
6. Bay City, Mich., 1886–87, 1893–96, 1900.
7. Billerica, Mass., 1899-1900.
8. Boston, Mass., 1886–94, 1897, 1900.†
9. Brockton, Mass., 1893–1900.
10. Burlington, Vt., 1886–1900.
11. Cambridge, Mass., 1900.†
12. Chelsea, Mass., 1900.†
13. Concord, N. H., 1895, 1898, 1900.
14. Dover, N. H., 1900.*
15. Erie, Pa., 1900.*
16. Essex Junc., Vt., 1900.†
17. Fall River, Mass., 1886–95, 1897–1900.
18. Fitchburg, Mass., 1886–92, 1894–1900.
19. Geneva, N. Y., 1900.*
20. Haverhill, Mass., 1900.*
21. Holyoke, Mass., 1886–92, 1897–98, 1900.
22. Hull, England, 1900.*
23. Ipswich, Mass., 1900.*
24. Keene, N. H., 1899–1900.
25. Leicester, Mass., 1900.*
26. Leominster, Mass., 1900.*
27. Lewiston, Me., 1900.*
28. Lowell, Mass., 1886, 1897–1900.
29. Lynn, Mass., 1888–98, 1900.
30. Madison, Wis., 1900.
31. Manchester, N. H., 1900.*
32. Marlboro, Mass., 1900.*
33. Metropolitan Water Works, Mass., 1900.
34. Middleboro, Mass., 1895–1900.
35. Minneapolis, Minn., 1900.
36. Nantucket, Mass., 1900.†
37. Nashua, N. H., 1900.†
38. New Bedford, Mass., 1886–1900.
39. New London, Conn., 1886–1900.
40. Newton, Mass., 1888–1900.
41. Oberlin, Ohio, 1893–1900.
42. Plymouth, Mass., 1886–1900.
43. Providence, R. I., 1897–1900.
44. Quincy, Mass., 1893, 1900.†
45. Reading, Mass., 1893, 1895–1900.
46. Salem, Mass., 1900.*
47. Sandusky, Ohio, 1886.
48. Schenectady, N. Y., 1886, 1900.*
49. Somerville, Mass., 1900.†
50. Springfield, Mass., 1886–1900.
51. Taunton, Mass., 1886–1900.
52. Toronto, Canada, 1893.
53. Trenton, N. J., 1886–87.
54. Troy, N. Y., 1886, 1888–93, 1897–99.
55. Waltham, Mass., 1886–1900.
56. Ware, Mass., 1886, 1888–92, 1900.
57. Watertown, Mass., 1900.*
58. Wellesley, Mass., 1888–93, 1898–1900.
59. Whitman, Mass., 1897–1900.
60. Wilmington, Del., 1900.*
61. Winchendon, Mass., 1900.*
62. Woburn, Mass., 1900.*
63. Woonsocket, R. I., 1886–1900.
64. Worcester, Mass., 1900.*
65. Yonkers, N. Y., 1893–96, 1900.*

* Compiled by the Editor. † Manuscript Summary.

Number.	Name of City or Town.	Date of Construction.	By whom Owned.	Source of Supply.	Mode of Supply.	1	2.—Description of Coal Used.					
						Builders of Pumping Machinery.	*a*—*b* Kind.	*c* Size.	*d* Brand.	*e* Av. Price per Gross Ton.	*f* Per Cent. of Ash.	*g* Wood. Price per Cord.
1	*Albany, N. Y.* . .	. .	City.	Hudson River (filtered) and Storage Reservoirs.	Pumping and Gravity.	. . .	. . .	. .	. . .	. .	. .	. .
2	*Andover, Mass.* .	. .	Town.	. . .	. . .	. . .	. . .	. .	. . .	. .	. .	. .
3	*Arlington, Mass.* .	. .	Town.	Metropolitan W. W.	. . .	. . .	. . .	. .	. . .	. .	. .	. .
4	Atlantic City, N. J.	1882 1888	City.	Driven Wells and Absecon Creek.	Pumping.	Worthington, Gordon-Maxwell.	Bituminous.	Run of Mine.	. . .	$3 18	6.4	. .
				5 Artesian Wells.	Pumping.	Smith-Vaile.	Anthracite.	Pea.	. . .	3 53	8.5	. .
5	Attleboro, Mass. .	1873	Town.	Large Well.	Pumping.	Deane, Barr.	Bituminous.	. .	Georges Creek, Clearfield.	. .	. .	. .
6	Bay City, Mich. . .	1872	City.	Saginaw Bay.	Pumping.	Holly.	Bituminous.	Slack.	Bay County.	1 53	. .	$0 50
7	Billerica, Mass. . .	1898	Town.	Driven Wells.	Pumping.	Barr.	Bituminous.	. .	Georges Creek.	. .	. .	. .
8	Boston, Mass. . .	1848	City.	Metropolitan W. W.	. . .	. . .	. . .	. .	. . .	. .	. .	. .
9	Brockton, Mass. .	1880	City.	Salisbury Brook.	Pumping.	Worthington, Holly.	. . .	. .	. . .	. .	. .	. .
10	Burlington, Vt. .	1867–68	City.	Lake Champlain.	Pumping.	Worthington.	Bituminous.	. .	Reynoldsville.	3 70	.	Mill Shavings.
11	Cambridge, Mass. .	. .	City.	Stony Brook.	Pumping.	. . .	. . .	. .	. . .	. .	. .	. .
12	Chelsea, Mass. . .	1867	City.	Metropolitan W. W.	. . .	. . .	. . .	. .	. . .	. .	. .	. .
13	Concord, N. H. . .	1872	City.	Penacook Lake.	Gravity and Pumping.	. . .	. . .	. .	Pocahontas.	. .	. .	. .
14	*Dover, N. H.* . .	. .	Town.	. . .	Pumping.	. . .	. . .	. .	. . .	. .	. .	. .
15	*Erie, Pa.*	1868	City.	Lake Erie.	Pumping.	Cornish, Holly, Worthington.	Bituminous.	Slack.	. . .	. .	. .	. .
16	Essex Junc., Vt. .	1900	Village.	Springs.	Gravity.	. . .	. . .	. .	. . .	. .	. .	. .

17	Fall River, Mass. .	1874	City.	Watuppa Lake.	Pumping.	Worthington, Davidson.	Bituminous.	. .	Georges Creek.	. .	. .	. .
18	Fitchburg, Mass. .	1873	City.	Storage Reservoirs.	Gravity.	. . .	. . .	. .	. . .	. .	. .	. .
19	*Geneva, N. Y.* . .	. .	City.	. . .	Pumping and Gravity.	. . .	. . .	. .	. . .	. .	. .	. .
20	*Haverhill, Mass.* .	. .	City.	Kenoza Lake.	Pumping.	. . .	. . .	. .	. . .	. .	. .	. .
21	Holyoke, Mass. . .	1873	City.	Lakes and Storage Reservoirs.	Gravity.	. . .	. . .	. .	. . .	. .	. .	. .
22	*Hull, England* . .	. .	City.	Deep Wells.	Pumping.	. . .	. . .	. .	. . .	. .	. .	. .
23	*Ipswich, Mass.* . .	1893	Town.	. . .	Pumping.	. . .	. . .	. .	. . .	. .	. .	. .
24	Keene, N. H. . .	1868	City.	Sylvan and Echo Lakes.	Gravity.	. . .	. . .	. .	. . .	. .	. .	. .
25	*Leicester, Mass.* .	. .	. .	. . .	. . .	. . .	. . .	. .	. . .	. .	. .	. .
26	*Leominster, Mass.*	. .	. .	. . .	. . .	. . .	. . .	. .	. . .	. .	. .	. .
27	*Lewiston, Me.* . .	. .	City.	Lake Auburn.	Pumping.	. . .	. . .	. .	. . .	. .	. .	. .
28	Lowell, Mass. . .	1870	City.	Driven Wells.	Pumping.	Blake, Barr, Morris, Worthington, Deane, Knowles.	Bituminous.	Broken.	Cumberland.	$4 60	. .	. .
29	Lynn, Mass. . . .	1870	City.	Storage Reservoirs and Saugus River.	Pumping.	Morris, Loretz.	Bituminous.	. .	Georges Creek.	. .	. .	. .
30	Madison, Wis. . .	1881	City.	10 Artesian Wells.	Pumping.	. . .	Anthracite.	Pea.	. . .	4 39	. .	. .
31	*Manchester, N. H.*	. .	City.	Lake Massabesic.	. . .	Davidson, R. D. Wood & Co.	. . .	. .	. . .	. .	. .	. .
32	*Marlboro, Mass.* .	. .	City.	Lake Williams.	Pumping.	Blake, Barr, Worthington.	. . .	. .	. . .	. .	. .	. .
						Chestnut	*Hill High*	*Service*	*Pumping*	*Station.*		
33	Metropolitan Water District, Mass. (excepting Newton and Hyde Park, and including Swampscott) . .	1848 1872–8 1895—	State of Massachusetts.	Lake Cochituate, Sudbury River, Nashua River.	32.4% Pumping. 67.6% Gravity.	Holly, Quintard,	Bituminous.	. .	Georges Creek, Loyal Hanna.	4 00	8.8	. .
						Allis.	Anthracite.	Scr'ngs.				
						Chestnut	*Hill Low*	*Service*	*Pumping*	*Station.*		
						Holly.	Bituminous.	. .	Loyal Hanna.	4 50	9.2	. .

Number.	Name of City or Town.	Date of Construction.	By whom Owned.	Source of Supply.	Mode of Supply.	1	2.—Description of Coal Used.					
						Builders of Pumping Machinery.	*a*—*b* Kind.	*c* Size.	*d* Brand.	*e* Av. Price per Gross Ton.	*f* Per Cent. of Ash.	*g* Wor'd. Price Per Cord.
							Spot	*Pond*	*Pumping*	*Station.*		
	Metropolitan Water District. —*Continued.*	. .	. .	. . .	. . .	Blake, Holly.	Anthracite. Bit. and Anth.	. . Scr'ngs.	. . .	$4 72	12.3	. .
34	Middleboro, Mass. .	1885	Fire Dist.	Well near Nemasket River.	Pumping.	Deane.	Bituminous.	. .	Georges Creek, Pocahontas.	3 85 5 10	. .	. .
35	Minneapolis, Minn.	1868	City.	Mississippi River.	Pumping.	Various.	Sawdust & Water Power.	. .	. . .	. .	. .	. .
36	Nantucket, Mass. .	. .	Wannacomet Water Co.	Wannacomet Pond.	Pumping.	Blake, Worthington, Fairbanks-Morse.	Bituminous.	. .	. . .	4 56	. .	. .
37	Nashua, N. H. . . .	1853	Pennichuck W. W. Co.	Pennichuck Springs.	Pumping.	Worthington, Snow, Holly.	Bituminous.	. .	Georges Creek.	4 75	7.3	. .
38	New Bedford, Mass.	1866	City.	Great and Little Quittacas Ponds.	Pumping.	Dickson Mfg. Co.	Bituminous.	. .	Poc'h'tas.	3 75 4 95	7.	$4 00
39	New London, Conn.	1872	City.	Lake Konomoc.	Gravity.	. . .	. . .	. .	. . .	. .	. .	. .
40	Newton, Mass. . . .	1876	City.	Collecting Gallery.	Pumping.	Blake, Worthington.	Bituminous.	Broken.	Georges Creek.	5 00	8.	6 00
41	Oberlin, Ohio	1887	City.	Vermilion River.	Pumping.	Deane.	Bituminous.	Run of Mine.	Pocahontas.	3 69	. .	. .
42	Plymouth, Mass. . .	1855	Town.	Great and Little South Ponds, Lout Pond.	Gravity and Pumping.	Worthington.	Bituminous.	. .	Various.	5 00	. .	. .

43	Providence, R. I. . .	1870	City.	Pawtuxet River.	Pumping.	Worthington, Corliss,	Bituminous. Bituminous.	. . . .	New River Georges Creek. New River.	$4 15 4 31	. . . .	$4 50 4 50
						Holly.	Anthracite.	Egg.	Reading, Beaver Meadow.	5 04	. .	5 00
44	Quincy, Mass. . . .	. .	City.	Metropolitan W. W.	. . .	. . .	. . .	. .	. . .	. .	. .	. .
45	Reading, Mass. . . .	1890–91	Town.	Filter Gallery.	Pumping.	Blake.	Coke, Bit.	. .	Georges Creek.	4 60 5 40	. .	. .
46	*Salem, Mass.*	. .	City.	Storage Reservoirs.	Pumping.	. . .	. . .	. .	. . .	. .	12.5	. .
47	*Schenectady, N. Y.*	. .	City.	Filter Gallery.	Pumping.	Dean.	. . .	. .	. . .	. .	. .	. .
48	Somerville, Mass. .	1868	City.	Metropolitan W. W.	. . .	. . .	. . .	. .	. . .	. .	. .	. .
49	Springfield, Mass. .	1864	City.	Storage Reservoirs.	Gravity.	. . .	. . .	. .	. . .	. .	. .	. .
50	Taunton, Mass. . . .	1876	City.	Elder's and Assawompsett Ponds.	Pumping.	Holly, Allis.	Bituminous.	. .	Cumberland.	4 25 4 75	12.3 9.5	. . . .
51	Waltham, Mass. . .	1872	City.	Filter Basin.	Pumping.	Barr, Worthington.	Bituminous.	. .	Georges Creek, Sonman	4 85	10.	. .
52	Ware, Mass.	. .	Town.	Wells.	Pumping.	Dean.	. . .	. .	. . .	. .	. .	. .
53	*Watertown, Mass.*	1884	Town.	Metropolitan W. W.	. . .	. . .	. . .	. .	. . .	. .	. .	. .
54	Wellesley, Mass. . .	1884	Town.	Wells.	Pumping.	Blake.	Bituminous.	. .	Georges Creek, Puritan.	3 76	9.9	3 50
55	Whitman, Mass. . .	1883–84	Town.	Well.	Pumping.	Blake, Worthington.	. . .	. .	. . .	. .	. .	. .
56	*Wilmington, Del.* .	. .	City.	Brandywine Creek.	Pumping.	. . .	. . .	. .	. . .	. .	. .	. .
57	*Winchendon, Mass.*	. .	Town.	. . .	Pumping.	. . .	. . .	. .	. . .	. .	. .	. .
58	*Woburn, Mass.* . .	1873	City.	. . .	Pumping.	. . .	. . .	. .	. . .	. .	. .	. .
59	Woonsocket, R. I. .	1884	City.	Crook Falls Brook.	Pumping.	Worthington. Deane.	Bituminous.	. .	Clearfield, New River.	5 29	7.3	3 00
60	*Worcester, Mass.* .	. .	City.	Storage Reservoirs.	. . .	. . .	. . .	. .	. . .	. .	. .	. .
61	*Yonkers, N. Y.* . .	. .	City.	Storage Reservoirs and Tubular Wells.	Pumping.	. . .	. . .	. .	. . .	. .	. .	. .

* Estimated.

Number.	3 Coal Consumed for the Year. Lbs.	4 Lbs. of Wood ÷ 3 = equivalent Coal.	5 Total Fuel Consumed for the Year. Lbs. (3) + (4).	6 Total Pumpage for the Year in gallons.	7 Average Static Head against which Pumps Work. Feet.	8 Average Dynamic Head against which Pumps Work. Feet.	9 Number of Gallons Pumped per Lb. of Fuel.	10 Duty in Foot-pounds per 100 Pounds of Coal. No Deductions.	11 Cost per Million Gallons Pumped into Reservoir, figured on Pumping Station Expenses.	12 Cost per Million Gallons raised 1 foot high, figured on Pumping Station Expenses.	13 Cost per Million Gallons Pumped into Reservoir, figured on Total Maint'n'ce (CC).	14 Cost per Million Gallons raised 1 foot high, figured on Total Maint'n'ce (CC).
2	487 891	. .	. . .	148 618 936	. .	330	. .	83 767 750	. . .	. . .	. . .	. . .
4	{ 2 693 222 { 950 752	. .	. . .	955 726 046 148 662 947	81 7 119 5	123 3 119 5	355 156	36 501 217 15 518 455	$10 14	. . .	$ 30 04	$0 264
5	612 345	. .	. . .	165 174 450	. .	{ 188 { 215	269	53 300 000	. . .	. . .	. . .	. . .
6	4 665 950	5 670	4 671 620	1 142 339 229	93	113	244	23 044 756	6 53	$0 0578	32 50	0 2875
7	247 000	. .	. . .	20 487 044	. .	. . .	114	21 559 031	. . .	. . .	. . .	. . .
9	441 001	. .	. . .	425 363 414	. .	43	965	. . .	. . .	. . .	. . .	. . .
10	. . .	. .	. . .	312 896 525	289	316	. .	. . .	26 17	0 08	114 55	0 366
11	3 866 975	. .	. . .	2 651 277 240	. .	. . .	. .	. . .	. . .	. . .	. . .	. . .
13	285 606	. .	. . .	142 772 165	. .	. . .	499	. . .	. . .	. . .	. . .	. . .
14	707 560	. .	. . .	258 258 044	. .	. . .	. .	40 000 000 [1]	. . .	. . .	. . .	. . .
15	11 800 000	. .	. . .	3 124 440 644	235 5	. . .	316	. . .	. . .	. . .	. . .	. . .
17	3 914 000	. .	. . .	1 388 776 336	186 2	. . .	317	. . .	12 77	. . .	102 34	. . .
19	1 758 046	. .	. . .	255 934 811	. .	240	170	29 100 000	21 75	. . .	. . .	. . .
20	. . .	. .	. . .	838 038 893	. .	. . .	. .	. . .	. . .	. . .	. . .	. . .
23	243 185	. .	. . .	39 444 884	. .	. . .	. .	. . .	. . .	. . .	. . .	. . .
27	. . .	. .	. . .	1 456 365 000	. .	. . .	. .	. . .	. . .	. . .	. . .	. . .
28	*Station I.* 2 982 990 *Total.* 10 684 561	2 400	2 985 390 . . .	2 042 066 140 2 884 271 028	156 1 . .	163 9 . . .	685 275	93 489 048 . . .	6 53 . . .	0 0399 . . .	. . . . . .	. . . . . .
29	{ 593 700 { 2 123 400	. . 158	593 700 2 123 558	378 782 675 1 330 784 875	. . . .	167 167	638 626	88 780 036 87 265 319	7 02	0 042	85 10	0 51
30	1 441 600	. .	. . .	306 637 454	223 8	242 4	212	47 530 839	38 43	0 159	. . .	. . .
32	. . .	. .	. . .	179 923 700	. .	. . .	. .	{ W 47 948 000 { B 78 368 780	. . .	. . .	. . .	. . .

	Chestnut	*Hill*	*High Service*	*Pumping Station.*									
	9 946 452	. .	. . .	15 027 410 000	. .	96 5	1 511	121 800 000	$ 3 03	$ 0 0314	. . .	. . .
33	*Chestnut*	*Hill*	*Low Service*	*Pumping Station.*									
	3 779 657	. .	. . .	9 431 140 000	. .	51 8	2 495	109 380 000	1 68	0 032	. . .	. . .
	Spot Pond	*Pumping Station.*											
	2 621 559	. .	. . .	2 015 130 000	. .	125 6	768	80 400 000	5 40	0 043	. . .	. . .
34	563 440	. .	563 440	85 032 000	182	203	151	25 663 050	35 66	0 175	$ 91 55	$0 45
35	Sawdust.											
	63 672 000	. .	= 15 918 000	6 863 135 200	. .	. . .	. .	68 016 609	7 38	0 033	. . .	. . .
36	298 740	675[2]	. . .	45 710 040	88	100	131	11 145 620	58 38	0 58	124 80	1 25
37	1 547 000	. .	. . .	1 398 936 786	130	143	. .	. . .	4 20	. . .	23 70	. . .
38	2 834 275	129	2 834 404	2 307 429 372	167 2	192	814	130 336 508	4 98	0 0259	55 04	0 2867
40	2 225 166	6 000	2 231 166	762 876 073	234	254	334	72 500 000	12 72	0 05	150 25	0 59
41	282 000	. .	. . .	36 560 600	80	80	130	8 650 000	38 80	0 48	119 50	1 50
42	306 518	4 500	320 018	120 233 312	65	66	425	24 626 739	17 01	0 25	96 36	1 46
43	5 581 300	133	5 581 433	3 833 243 445	171 6	176 9	687	101 301 600	L. S. 4 59	0 0259	. . .	. . .
	72 800	750	73 550	34 401 038	172 4	177 7	473	69 329 100				
	877 631	563	878 194	578 940 480	111 2	124 7	660	68 533 300	H. S. 15 49	0 1134	. . .	. . .
45	435 560	. .	435 560	54 250 465	219	240	125	24 900 000	52 99	0 221	278 49	1 16
46	1 932 046	. .	. . .	985 252 640	. .	127	510	65 942 930	. . .	. . .	. . .	. . .
50	982 400	. .	982 400	591 294 779	. .	61 5	602	30 880 224	10 58	0 172	91 76	1 49
	415 200	. .	415 200	500 809 575	. .	. . .	. .	. . .				
51	1 270 655	. .	. . .	773 020 136	164	180	W 293 B 663	91 327 530	10 49	0 058	57 17	0 318
52	551 696	667	552 363	107 481 728	. .	244	194	39 579 333	. . .	. . .	75 70	. . .
54	477 100	317	477 417	87 194 763	250	278	183	42 121 882	26 56	0 095	199 42	0 717
55	412 019	. .	. . .	48 661 422	. .	. . .	. .	. . .	. . .	. . .	. . .	. . .
57	104 162	. .	. . .	20 542 416	. .	. . .	. .	43 314 734	. . .	. . .	. . .	. . .
58	. . .	. .	. . .	417 435 900	. . .	216 2	271	. . .	. . .	. . .	. . .	. . .
59	1 334 200	335	1 334 535	340 849 628	237 6	239 5	255	51 024 641	14 70	0 061	88 45	0 37
61	6 148 225	. .	. . .	1 323 696 099	. .	. . .	216	. . .	. . .	. . .	. . .	. . .

[1] About. [2] Gallons Gasolene.

Number.	Name of City or Town.	Receipts from Consumers.						
		A	B	N	Q	C	D	E
		Rates. Domestic.	Rates. Manufacturing.	Fixture Rates.	Meter Rates.	Net Receipts for Water.	Miscellaneous Receipts.	Total Receipts from Con-umers.
2	*Andover, Mass.*	. . .	. . .	. . .	. . .	$ 10 668 47	$ 2 061 70	$ 12 730 17
3	*Arlington, Mass.*	. . .	. . .	. . .	. . .	30 523 37	. . .	. . .
4	Atlantic City, N. J.	. . .	. . .	. . .	. . .	81 500 65	13 745 80 [1]	. . .
5	Attleboro, Mass.	. . .	. . .	. . .	. . .	21 424 41	. . .	. . .
6	Bay City, Mich.	$ 18 194 91	$ 5 921 24	. . .	. . .	24 116 15	240 10	24 356 25
7	Billerica, Mass.	. . .	. . .	$ 1 405 80	$ 1 162 62	. . .	. . .	. . .
8	Boston, Mass.	. . .	. . .	. . .	. . .	2 198 078 93	361 948 10	2 560 027 03
9	Brockton, Mass.	. . .	. . .	8 396 06	58 468 06	66 864 12	6 517 80	73 381 92
10	Burlington, Vt.	38 239 01	3 953 21	9 689 17	59 404 29	42 192 22	1 914 69	44 106 91
11	Cambridge, Mass.	. . .	. . .	. . .	. . .	. . .	. . .	319 479 37
12	Chelsea, Mass.	64 572 81	14 925 91	. . .	. . .	79 498 72	4 237 63	83 736 35
13	Concord, N. H.	. . .	. . .	25 274 77	31 485 63	56 882 92	146 04	57 003 71
15	*Erie, Pa.*	. . .	. . .	99 047 99	22 411 31	121 459 30	3 019 73	124 477 03
16	Essex Junc., Vt.	650 00	. . .	. . .	. . .	650 00	600 00	1 250 00
17	Fall River, Mass.	. . .	. . .	. . .	. . .	163 896 19	4 736 97	168 633 16
18	Fitchburg, Mass.	50 833 90	17 638 50	22 941 75	45 530 65	68 472 40	4 542 51	73 014 91
19	*Geneva, N. Y.*	. . .	. . .	7 781 25	9 212 54	. . .	. . .	. . .
20	*Haverhill, Mass.*	. . .	. . .	. . .	. . .	97 185 73	7 123 30	104 309 03
21	Holyoke, Mass.	. . .	. . .	69 780 53	14 571 63	84 352 16	. . .	. . .
24	Keene, N. H.	. . .	. . .	. . .	. . .	34 499 72	. . .	. . .
25	*Leicester, Mass.*	. . .	. . .	. . .	. . .	4 966 58	1 163 46 [1]	. . .
26	*Leominster, Mass.*	. . .	. . .	27 493 42	8 575 90	36 069 32	1 878 53 [1]	. . .
28	Lowell, Mass.	. . .	. . .	. . .	. . .	210 149 93	. . .	. . .
29	Lynn, Mass.	121 280 58	73 558 75	. . .	. . .	194 839 33	13 983 70	208 823 03
31	*Manchester, N. H.*	. . .	. . .	. . .	. . .	119 441 75	375 19	119 816 94
32	*Marlboro, Mass.*	. . .	. . .	. . .	. . .	31 867 09	1 449 51	. . .

34	Middleboro, Mass.	. . .	. . .	$ 3 659 38	$ 7 067 70	$ 10 727 08	$ 318 52	$ 11 045 60
37	Nashua, N. H.	. . .	. . .	. . .	. . .	. . .	. . .	. . .
38	New Bedford, Mass.	$93 403 62	$10 367 84	. . .	. .	103 771 46	273 13	104 044 50
39	New London, Conn.	. . .	. . .	. . .	. . .	49 063 89	. . .	. . .
40	Newton, Mass.	. . .	. . .	18 447 11	111 580 60	130 027 71	. . .	130 027 71
41	Oberlin, Ohio	5 098 97	246 00	. . .	. . .	5 344 97	499 22	5 844 19
42	Plymouth, Mass.	20 511 41	1 454 32	. . .	. . .	21 965 73	602 80	22 568 53
45	Reading, Mass.	8 465 64	114 63	. . .	. . .	8 580 27	339 92	8 920 19
46	*Salem, Mass.*	. . .	. . .	63 703 04	16 313 08	80 016 12	1 948 74	81 964 86
47	*Schenectady, N. Y.*	. . .	. . .	. . .	. . .	74 748 69	. . .	81 056 15
48	Somerville, Mass.	. . .	. . .	102 396 84	48 204 61	210 601 45	. . .	210 601 45
49	Springfield, Mass.	. . .	. . .	146 204 44	66 922 07	213 126 51	783 00	. . .
50	Taunton, Mass.	43 025 26	12 811 08	. . .	. . .	55 836 34	713 05	56 549 39
51	Waltham, Mass.	57 839 19	7 114 07	. . .	. . .	64 953 26	2 959 93 [1] 2 353 90	70 267 09
52	Ware, Mass.	. . .	. . .	. . .	8 576 69	. . .	573 28	. . .
53	*Watertown, Mass.*	. . .	. . .	2 022 75	23 273 88	25 296 63	. . .	. . .
54	Wellesley, Mass.	12 556 34	189 48	. . .	. . .	12 745 82	1 519 83	14 265 65
55	Whitman, Mass.	5 989 13	622 16	2 453 82	4 157 47	6 611 29	739 01	7 350 30
57	*Winchendon, Mass.*	3 787 02	. . .	. . .	. . .	. . .	. . .	. . .
58	*Woburn, Mass.*	. . .	. . .	. . .	. . .	. . .	845 18	. . .
59	Woonsocket, R. I.	40 970 45	10 932 43	. . .	. . .	51 902 88	116 83	52 019 71
60	*Worcester, Mass.*	. . .	. . .	. . .	. . .	. . .	. . .	. . .
61	*Yonkers, N. Y.*	. . .	. . .	. . .	. . .	124 234 08	1 870 85	126 104 93

[1] Balance from previous year.

Number.	RECEIPTS FROM PUBLIC FUNDS.						K	EXPENDITURES.				
	F	G	H	I	J			AA	BB	CC	DD	EE
	Hydrants.	Fountains.	Street Watering.	Public Buildings.	General Appropriation or Miscellaneous.	Total from Public Funds.	GROSS RECEIPTS FROM ALL SOURCES.	Management and Repairs.	Interest on Bonds.	Total Maintenance for the Year.	Balance.	Total.
2	. . .	. . .	. . .	. . .	. . .	. . .	. . .	$ 4 915 23	$ 6 000 00	. . .	. . .	. . .
3	. . .	. . .	. . .	. . .	. . .	. . .	$ 43 835 45	. . .	12 560 00	. . .	. . .	. . .
4	. . .	. . .	. . .	. . .	$ 2 800 00	. . .	123 246 45	41 549 27	44 015 00	. . .	$21 000 00[2] 13 887 99[3] 2 794 19	$123 246 45
5	. . .	. . .	. . .	. . .	6 000 00	. . .	27 424 41	9 238 39	13 183 44	$ 22 421 83	5 000 00[2] 2 58	27 424 41
6	. . .	. . .	. . .	. . .	22 390 00	. . .	46 746 25	14 739 19	22 390 00	37 129 19	9 617 06	46 746 25
7	$ 2 300 00	. . .	. . .	. . .	1 000 00	$ 3 300 00	5 984 90	2 006 56	3 600 00	5 606 56	378 34	5 984 90
8	. . .	. . .	. . .	. . .	161 724 47	. . .	2 721 751 50	1 085 860 92	805 924 26	. . .	. . .	. . .
9	3 000 00	. . .	$1 000 00	. . .	. . .	4 000 00	77 381 92	16 412 56	31 957 50	48 370 06	29 011 86[2]	77 381 92
10	3 540 00	$ 230 45[5]	2 056 34	$586 23[5]	488 22	6 901 24	51 008 15	26 280 82	9 920 00	36 200 82	12 296 58[2] 2 200 00[3] 310 75[4]	51 008 15
12	2 002 50	7 50	1 888 02	706 24	. . .	4 604 26	88 340 61	14 799 41	12 000 00	26 799 41	. . .	. . .
13	. . .	. . .	. . .	. . .	. . .	. . .	. . .	27 348 55	25 825 00	. . .	. . .	. . .
15	32 725 00	1 410 46	147 78	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
16	405 00	. . .	. . .	. . .	. . .	405 00	1 655 00	. . .	1 480 00	. . .	. . .	. . .
17	. . .	. . .	. . .	. . .	11 700 28	. . .	180 333 44	51 615 47	98 205 00	149 820 47	30 512 97	180 333 44
18	. . .	. . .	. . .	. . .	. . .	. . .	73 014 91	. . .	. . .	36 740 69[6]	36 274 22[4]	73 014 91
19	. . .	. . .	. . .	. . .	. . .	. . .	18 980 89	11 342 25	. . .	. . .	. . .	. . .
20	. . .	. . .	. . .	. . .	. . .	. . .	. . .	22 420 48	39 440 00	. . .	17 000 00[2]	. . .
21	. . .	. . .	. . .	. . .	. . .	. . .	182 767 79	27 499 29	18 500 00	45 999 29	13 567 50[2] 97 438 89[3]	. . .
24	5 375 00	350 00	1 200 00	175 00	. . .	7 100 00	30 599 72	2 049 61	3 095 00	5 144 61	25 455 11[4]	30 599 72
25	1 300 00	. . .	. . .	. . .	. . .	. . .	7 430 04	. . .	2 806 00	5 460 51	. . .	. . .
26	11 800 00	. . .	. . .	. . .	. . .	12 837 26	. . .	1 945 05	12 912 50	14 857 55	. . .	. . .
28	. . .	. . .	. . .	. . .	. . .	. . .	. . .	83 630 39	49 307 00	132 937 39	. . .	. . .
29	. . .	. . .	. . .	. . .	. . .	. . .	208 823 03	62 717 77	73 796 24	136 514 01	72 309 02[2]	208 823 03
31	18 425 00	. . .	. . .	. . .	. . .	. . .	138 241 94	31 419 27	39 534 50	. . .	. . .	. . .
32	6 760 00	. . .	. . .	. . .	. . .	. . .	40 076 60	. . .	. . .	. . .	. . .	. . .
34	. . .	. . .	. . .	. . .	3 778 03[1] 1 500 00	. . .	16 323 63	5 405 51	2 380 00	7 785 51	3 000 00[2] 2 608 03[3] 2 930 09	16 323 63

37	$ 7 230 00	$ 225 00	$ 700 00	$ 759 73	. . .	$ 8 214 73	. . .	. . .	. . .	. . .	. . .	. . .
38	. . .	. . .	. . .	. . .	$133 440 00	133 440 00	$237 484 59	$48 560 92	$ 78 440 00	$127 000 92	$28 000 00[2] 4 483 67[3] 78 000 00[7]	$237 484 59
39	10 320 00	150 00	4 000 00	400 00	. . .	. . .	63 933 89	9 055 34	14 915 00	23 970 04	39 963 85[3]	63 933 89
40	. . .	. . .	. . .	. . .	. . .	. . .	. . .	17 124 42	97 500 00	114 624 42	15 403 29	130 027 71
41	. . .	. . .	. . .	. . .	3 400 00	. . .	9 244 19	2 723 88	1 645 00	4 368 88	2 395 27[3] 2 480 04[2]	9 244 19
42	. . .	. . .	. . .	. . .	. . .	0	22 568 53	11 090 57	3 637 15	14 727 72	7 840 81	22 568 53
45	3 930 00	300 00	. . .	. . .	2 470 00	6 700 00	15 620 19	6 453 99	8 700 00	15 153 99	466 20	15 620 19
47	0	0	0	0	. . .	. . .	. . .	. . .	19 750 00	. . .	. . .	. . .
49	19 100 00	1 745 00	5 615 06	9 649 75	0	36 109 81	274 954 75	27 014 24	89 000 00	116 014 24	. . .	. . .
50	0	2 572 92	800 00	637 26	8 556 40	12 566 58	69 115 97	23 590 18	30 668 00	54 258 18	14 857 79[2]	69 115 97
51	. . .	. . .	. . .	. . .	. . .	. . .	70 267 09	27 780 33	16 415 00	44 195 33	22 028 16[2] 4 043 60	70 267 09
52	1 000 00	171 45	. . .	265 43	. .	. . .	10 859 39	. . .	. . .	7 875 99	1 500 00[3]	. . .
53	. . .	. . .	. . .	. . .	. . .	. . .	29 156 06	3 301 60	. . .	. . .	. . .	. . .
54	4 720 00	400 00	300 00	149 85	. . .	5 569 85	19 835 50	6 488 52	10 800 00	17,288 52	2 546 98	19 835 50
55	2 580 00	. . .	. . .	. . .	. . .	2 580 00	9 930 30	. . .	4 000 00	8 017 75	1 912 55[3]	9 930 30
57	3 600 00	200 00	167 82	. . .	. . .	. . .	7 772 81	. . .	3 840 00	5 861 37	1 911 44	7 772 81
58	1 730 00	. . .	. . .	. . .	. . .	. . .	44 201 44	13 450 68	5 725 38	. . .	25 025 38[2]	44 201 44
59	15 925 00	1 552 74	2 254 13	537 59	13 642 94	. . .	85 932 11	13 005 45	17 125 14	30 130 59	55 801 52	85 932 11
60	. . .	. . .	. . .	. . .	. . .	. . .	203 208 41	59 837 06	134 250 00	194 087 06	69 121 35[2]	. . .
61	21 840 00	. . .	. . .	. . .	. . .	. . .	147 944 93	47 579 67	76 950 00	124 529 67	29 379 20[2] −5 963 94[8]	147 944 93

[1] Balance from previous year. [2] To Sinking Fund. [3] To Construction Account. [4] To City Treasury. [5] Paid at Meter Rates. [6] Including *Construction*.
[7] Bonds Paid. [8] Deficit.

1900.—TABLE II., *Continued.*—FINANCIAL STATISTICS.—CONSTRUCTION.

Number.	Name of City or Town.	Construction Receipts.				
		R	S	T	U	V
		Balance from Previous Year.	Bonds Issued.	Appropriations from Tax Levy.	Other Sources.	Total.
1	*Albany, N. Y.*	. . .	. . .	. . .	. . .	. . .
2	*Andover, Mass.*	. . .	. . .	. . .	. . .	. . .
3	*Arlington, Mass*	. . .	. . .	. . .	. . .	. . .
4	Atlantic City, N. J.	. . .	. . .	. . .	$ 265 83 13 887 99 [1]	$ 14 153 82
5	Attleboro, Mass.	$ 9 116 26	$12 000 00	. . .	5 040 67	26 156 93
6	Bay City, Mich.	11 897 88	. . .	. . .	91 81 9 617 06 [1]	21 606 75
7	Billerica, Mass.	684 71	. . .	. . .	1 793 86	2 478 57
8	Boston, Mass.	40 230 54	. . .	. . .	386 988 24 [1]	427 218 78
9	Brockton, Mass.	8 682 01	15 000 00	. . .	3 178 21	26 860 22
10	Burlington, Vt.	. . .	. . .	. . .	2 200 00 [1]	2 200 00
11	Cambridge, Mass.	. . .	. . .	. . .	. . .	. . .
12	Chelsea, Mass.	. . .	. . .	. . .	. . .	. . .
13	Concord, N. H.	. . .	. . .	. . .	. . .	. . .
16	Essex Junc., Vt.	. . .	25 000 00	$700 00	12 800 00	38 500 00
17	Fall River, Mass.	. . .	20 000 00	. . .	. . .	20 000 00
18	Fitchburg, Mass.	. . .	. . .	. . .	. . .	. . .
19	*Geneva, N. Y.*	. . .	. . .	. . .	. . .	. . .
20	*Haverhill, Mass.*	10 544 19	57 965 00	. . .	. . .	. . .
21	Holyoke, Mass.	. . .	. . .	. . .	97 438 89 [1]	97 438 89
25	*Leicester, Mass.*	. . .	. . .	. . .	. . .	243 44
26	*Leominster, Mass.*	. . .	. . .	. . .	. . .	. . .
28	Lowell, Mass.	. . .	. . .	. . .	. . .	. . .
29	Lynn, Mass.	8 572 16	50 000 00	. . .	3 466 41	62 038 57
30	Madison, Wis.	. . .	. . .	. . .	. . .	. . .
31	*Manchester, N. H.*	54 054 36	. . .	. . .	. . .	. . .

32	*Marlboro, Mass.*	. . .	. . .	. . .	. . .	. . .
34	Middleboro, Mass.	. . .	. . .	. . .	$2 608 03 [1] 1 641 53	$ 4 249 56
38	New Bedford, Mass.	$12 836 92	. . .	. . .	4 483 67 [1] 8 280 38	25 600 97
39	New London, Conn.	34 446 64	. . .	. . .	39 963 85 [1]	74 410 49
40	Newton, Mass.	. . .	. . .	. . .	28 050 50	28 050 50
41	Oberlin, Ohio	497 74	. . .	. . .	2 395 27 [1] 290 25	3 183 26
42	Plymouth, Mass.	6 620 59	$30 021 00	. . .	1 200 81 [1]	38 442 40
43	Providence, R. I.	. . .	. . .	. . .	. . .	. . .
44	Quincy, Mass.	. . .	30 000 00	. . .	16 646 58	46 646 58
45	Reading, Mass.	1 233 18	11 439 00	. . .	466 20 [1] 870 32	14 008 70
46	*Salem, Mass.*	. . .	. . .	. . .	. . .	. . .
47	*Schenectady, N. Y.*	. . .	. . .	. . .	. . .	. . .
48	Somerville, Mass.	. . .	. . .	. . .	. . .	. . .
49	Springfield, Mass.	392 27	. . .	. . .	12 983 07 [1] 3 323 95	16 699 29
50	Taunton, Mass.	6 970 20	55 000 00	. . .	5 398 43	67 368 63
51	Waltham, Mass.	212 58	. . .	$20 000 00	2 549 95	22 762 53
52	Ware, Mass.	125 35	. . .	2 700 00	1 500 00 [1]	4 325 35
53	*Watertown, Mass.*	. . .	. . .	. . .	. . .	. . .
54	Wellesley, Mass.	545 15	12 000 00	. . .	867 85	13 413 00
55	Whitman, Mass.	2 817 58	. . .	. . .	96 23 [1] 1 912 55	4 826 36
57	*Winchendon, Mass.*	. . .	. . .	. . .	. . .	. . .
58	*Woburn, Mass.*	. . .	. . .	. . .	. . .	. . .
59	Woonsocket, R. I.	. . .	. . .	5 514 77	3 702 70	9 217 47
61	*Yonkers, N. Y.*	. . .	25 000 00	. . .	. . .	. . .

[1] From Maintenance Account.

Number.	CONSTRUCTION EXPENDITURES.						MISCELLANEOUS.			
	FF	GG	HH	II	JJ	KK	W	X	Y	Z
	Extensions.		Special.	Total Cost of Construction for the Year.	Balance.	Total.	Net Cost of Works to Date.	Bonded Debt at Date.	Value of Sinking Fund at Date.	Rate of Interest, Per Cent.
	Mains.	Services.								
1	. . .	. . .	. . .	. . .	. . .	. . .	. . .	$ 1 739 000 00	. . .	3.5 to 7
2	. . .	. . .	. . .	$ 3 485 69	. . .	. . .	$ 208 624 48	145 000 00	$ 9 296 16	. . .
3	$ 13 056 90	$ 1 014 60	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
4	9 277 90	. . .	$ 4 875 92	14 153 82	. . .	. . .	916 723 59	892 000 00	100 407 01	4.5 to 5
5	. . .	. . .	. . .	26 156 93	0	$ 26 156 93	374 488 18	305 000 00	62 430 10	. . .
6	9 726 39	. . .	645 15 [1]	10 371 54	$11 235 21	21 606 75	598 082 21	352 000 00	. . .	av. 6.25
7	. . .	. . .	. . .	2 433 16	45 41	2 478 57	91 705 87	90 000 00	. . .	. . .
8	324 395 11	40 208 95	. . .	364 604 06	62 614 72	427 218 78	23 054 387 81	11 960 273 98	10 144 647 08	3.5 to 6
9	16 161 01	. . .	6 587 75	22 748 76	4 111 46	26 860 22	913 211 06	777 000 00	317 925 96	4
10	1 660 04	539 96	. . .	2 200 00	0	2 200 00	468 039 73	248 000 00	64 076 40	3.5 to 4
11	. . .	. . .	. . .	. . .	. . .	. . .	5 670 229 52	3 302 100 00	604 326 58	. . .
12	3 292 49	. . .	. . .	3 292 49	. . .	. . .	483 335 52	300 000 00	50 921 00	4
13	. . .	. . .	. . .	. . .	. . .	. . .	857 440 98	650 000 00	. . .	. . .
16	. . .	. . .	. . .	38 500 00	. . .	. . .	38 500 00	25 000 00	0	4
17	19 942 45	. . .	. . .	19 942 45	57 55	20 000 00	1 937 862 93	1 920 000 00	581 647 78	5.1
18	. . .	. . .	. . .	. . .	. . .	. . .	452 091 09	648 000 00	195 908 91	. . .
19	. . .	. . .	. . .	7 313 30	. . .	. . .	181 628 73	. . .	. . .	. . .
20	8 221 75	2 879 63	32 604 26	43 705 64	. . .	. . .	1 300 142 54	1 006 000 00	142 596 03	4
21	51 641 02	1 331 51	. . .	97 438 89	0	97 438 89	1 244 742 23	300 000 00	37 403 46	4
25	. . .	. . .	. . .	555 08	. . .	. . .	81 002 87	70 000 00	8 376 42	. . .

26	. . .	. . .	. . .	. . .	. . .	. . .	$ 519 215 43	$ 292 000 00	. . .	. . .
28	. . .	. . .	. . .	. . .	. . .	. . .	. . .	1 274 700 00	$287 226 20	. . .
29	$ 7 346 71	$6 611 49	$34 768 63	$48 726 87	$13 311 70	$62 038 57	2 472 821 85	1 800 300 00	524 027 50	3.5 to 5
30	. . .	. . .	. . .	. . .	. . .	. . .	337 360 13	. . .	. . .	. . .
31	1 224 81	1 624 58	. . .	12 981 61	. . .	. . .	1 513 012 79	900 000 00	159 466 83	4 to 6
32	. . .	. . .	. . .	. . .	5 046 87	. . .	586 261 13	538 000 00	150 055 96	. . .
34	3 326 33	923 23	. . .	4 249 56	0	4 249 56	116 420 15	57 500 00	6 376 61	4
38	11 026 35	8 779 60	. . .	19 805 95	5 795 02	25 600 97	1 820 107 73	558 000 00	148 793 77	av. 4.44
39	11 557 41	1 359 86	2 205 11	15 122 38	59 288 11	74 410 49	706 978 44	410 000 00	. . .	3.5 to 4
40	. . .	. . .	. . .	28 050 50	0	28 050 50	2 034 808 07	2 075 000 00	849 115 40	av. 4.7
41	14 16	1 276 80	1 500 00	. . .	391 80	3 183 26	86 381 42	48 000 00	2 570 10	3.5 to 5.75
42	40 359 53	342 80	5 588 01	46 290 34	—7 847 94 [2]	38 442 40	313 189 09	105 960 00	. . .	4
43	. . .	. . .	. . .	. . .	. . .	. . .	6 470 093 35	5 920 000 00	713 431 62	av. 3.7
44	. . .	. . .	. . .	45 831 85	814 73	46 646 58	. . .	720 500 00	. . .	4
45	11 483 58	1 720 31	755 88	13 959 77	48 93	14 008 70	265 462 18	219 000 00	. . .	4
46	. . .	. . .	. . .	4 446 00	. . .	. . .	1 917 590 39	. . .	. . .	. . .
47	. . .	. . .	. . .	. . .	. . .	. . .	. . .	512 000 00	110 754 66	3 to 4
48	. . .	. . .	. . .	. . .	. . .	. . .	766 484 63	207 000 00	0 [3]	4 to 4.5
49	6 362 20	. . .	9 944 82	16 307 02	. . .	. . .	2 128 559 56	1 500 000 00	461 861 90	av. 5.9
50	10 981 42	4 744 37	13 299 33	29 025 12	38 343 51	67 368 63	1 243 185 49	812 000 00	174 028 88	4
51	. . .	. . .	. . .	17 172 04	5 590 49	22 762 53	614 000 00 [4]	426 000 00	98 407 17	3.5 to 4
52	. . .	. . .	. . .	4 247 44	77 91	4 325 35	131 090 08	41 400 00	. . .	3.5 to 4
53	. . .	. . .	. . .	8 966 14	. . .	. . .	309 169 56	. . .	. . .	. . .
54	8 703 64	1 252 04	2 174 19	12 129 87	1 283 13	13 413 00	322 718 24	278 000 00	82 790 82	4
55	. . .	. . .	. . .	2 351 08	2 475 28	4 826 36	129 632 93	100 000 00	34 894 51	4
57	1 996 42	. . .	. . .	. . .	. . .	. .	111 533 03	. . .	. . .	. . .
58	2 104 21	1 446 89	. . .	. . .	. . .	. . .	597 049 14	. . .	. . .	. . .
59	. . .	. . .	. . .	5 514 77	. . .	. . .	390 841 78	. . .	. . .	. . .
61	. . .	. . .	. . .	28 026 46	. . .	. . .	1 577 105 15	1 47› 000 00	310 700 00	3.5 to 7

[1] For Extension of Meters. [2] Deficit. [3] Maturing bonds paid from income. [4] Total bonds issued to date.

1900.—TABLE III.—STATISTICS OF CONSUMPTION OF WATER.

Number.	Name of City or Town.	1	2	3	4	5	6	Percentage of Total Consumption Metered.	7	8	9	10
		Estimated Population.			Total Consumption for the Year. (Gallons.)	Quantity Used through Domestic Meters. (Gallons.)	Quantity Used through Manufacturing Meters. (Gallons.)		Average Consumption. (Gallons per Day.)			
		Total at Date.	On Line of Pipe.	Supplied at Date.					Total.	To Each Inhabitant.	To Each Consumer.	To Each Tap.
1	*Albany, N. Y.*	. . .	. .	95 000	4 940 949 000 [1]	. . .	. . .	. .	18 099 000	. .	191	. .
2	*Andover, Mass.*	6 813	. .	. .	148 618 936	. . .	. . .	. .	407 172	60	. .	. .
3	*Arlington, Mass.*	8 603	. .	. .	. . .	. . .	. . .	. .	297 400 [2]	. .	. .	634 [2]
4	Atlantic City, N. J.	28 000	27 500	150 000 [3]	1 104 388 993	. . .	. . .	. .	. . .	. .	. .	737
5	Attleboro, Mass.	11 335	10 000	. .	165 174 450	. . .	. . .	. .	452 532	39	45	. .
6	Bay City, Mich.	28 000	20 000	16 000	1 142 339 229	70 440 246	174 634 975	21	3 129 697	112	196	1 425
7	Billerica, Mass.	2 780	1 800	1 230	20 487 044	. . .	. . .	. .	56 139	20	46	. .
8	Boston, Mass.	560 892	. .	. .	. . .	. . .	. . .	. .	. . .	. .	. .	. .
9	Brockton, Mass.	40 063	37 000	35 000	425 362 414	159 944 862	58 234 260	51	1 165 376	29	33	221
10	Burlington, Vt.	18 800	18 300	18 100	312 896 525	140 045 612	27 797 250	53	857 250	46	47	256
11	Cambridge, Mass.	91 886	. .	. .	2 651 277 240	. . .	. . .	. .	7 263 773	79	. .	. .
12	Chelsea, Mass.	34 000	34 000	34 000	1 095 000 000	24 539 205	110 415 517	12	3 000 000	87	87	488
13	Concord, N. H.	19 632	17 000	. .	. . .	. . .	. . .	. .	. . .	. .	. .	. .
15	*Erie, Pa.*	52 733	. .	. .	3 124 440 644	. . .	. . .	. .	8 560 111	162	. .	. .
16	Essex Junc., Vt.	1 125	800	500	. . .	. . .	. . .	. .	. . .	. .	. .	. .
17	Fall River, Mass.	107 623	. .	104 523	1 388 776 336	. . .	. . .	. .	3 804 867	35	36	. .
18	Fitchburg, Mass.	31 531	. .	27 000	1 022 000 000 [4]	. . .	. . .	. .	2 800 000 [4]	. .	103 [4]	. .
19	*Geneva, N. Y.*	11 000	. .	. .	328 000 000 [4]	79 504 100		24	. . .	81	. .	. .
20	*Haverhill, Mass.*	37 175	. .	. .	838 038 893	. . .	. . .	. .	2 268 868	61	. .	. .
21	Holyoke, Mass.	46 204	45 704	45 204	1 733 750 000 [4]	238 276 500		14	4 750 000 [4]	103	105	1 321
22	*Hull, England*	. . .	. .	242 000	4 020 000 000	. . .	. . .	22	11 010 000	. .	46	. .
23	*Ipswich, Mass.*	4 658	. .	. .	39 444 884	. . .	. . .	. .	109 164	23	. .	. .
24	Keene, N. H.	9 300	8 600	8 000	509 175 000 [4]	. . .	. . .	. .	1 395 000 [4]	150	174	808
25	*Leicester, Mass.*	1 398	. .	. .	14 966 850 [5]	. . .	2 111 550 [5]	. .	82 230	. .	59	. .
26	*Leominster, Mass.*	12 392	. .	. .	. . .	. . .	. . .	. .	. . .	. .	. .	. .
27	*Lewiston, Me.*	. . .	. .	. .	1 456 365 000	. . .	. . .	. .	3 990 041	. .	. .	. .
28	Lowell, Mass.	95 000	. .	. .	2 881 074 794	. . .	. . .	. .	7 892 356	83	. .	. .
29	Lynn, Mass.	73 600	. .	72 128	1 708 153 070	340 000 000		20	4 679 871	. .	65	. .
30	Madison, Wis.	19 164	. .	16 548	306 637 450	. . .	. . .	. .	837 332	44	51	304

32	*Marlboro, Mass.*	13 609	. .	11 726	179 921 700	. . .	. . .	. .	492 936	36	42	. .
33	Metropolitan W. W., Mass.	815 400	. .	. .	34 384 860 000	. . .	. . .	. .	94 205 000	116	. .	. .
34	Middleboro, Mass.	{ Town. 6 900 / F.Dist. 4 240 }	4 000	3 750	85 032 000	15 861 135	25 240 659	48	232 964	56	62	284
35	Minneapolis, Minn.	202 718	100 000	95 000	6 863 135 200	1 307 263 847		19	18 803 110	93	198	. .
36	Nantucket, Mass.	3 002	2 000	2 400 [3]	45 710 040	. . .	. . .	. .	125 233	42	52	134
37	Nashua, N. H.	25 000	24 000	23 900	1 398 936 786	. . .	. . .	. .	3 832 704	153	119	. .
38	New Bedford, Mass.	62 500	56 000	55 000	2 306 997 774	137 369 250	402 103 500	23	6 320 542	101	115	681
39	New London, Conn.	17 500	16 500	15 800	578 800 000 [4]	. . .	. . .	. .	1 585 770	91	100	514
40	Newton, Mass.	33 587	33 000	32 800	761 526 510	351 000 000	68 000 000	55	2 086 374	62	64	294
41	Oberlin, Ohio	4 800	3 600	2 800	36 560 000	14 500 000	1 220 000	43	100 000	21	36	160
42	Plymouth, Mass.	9 592	. .	. .	148 618 936	. . .	. . .	. .	407 172	43	. .	. .
43	Providence, R. I.	187 297	187 297	187 297	3 697 993 447	. . .	. . .	60 [4]	10 131 489	54	54	470
44	Quincy, Mass.	23 896	. .	. .	. . .	. . .	. . .	. .	. . .	. .	. .	. .
45	Reading, Mass.	4 969	4 550	4 200	54 250 465	. . .	. . .	. .	148 631	30	35	141
46	*Salem, Mass.*	35 956	. .	. .	985 252 640	. . .	. . .	. .	2 577 000	72	. .	. .
47	*Schenectady, N. Y.*	32 000	. .	7 050	. . .	. . .	. . .	. .	. . .	. .	166	. .
48	Somerville, Mass.	62 500	62 500	62 500	. . .	. . .	. . .	. .	. . .	. .	. .	. .
49	Springfield, Mass.	62 059	53 000	48 200	1 997 097 500 [4]	425 004 191		21	5 471 500 [4]	88 [4]	114 [4]	560 [4]
50	Taunton, Mass.	31 006	28 000	26 116	591 294 779	80 894 819	140 636 896	37	1 619 985	53	62	359
51	Waltham, Mass.	23 700	23 300	23 250	773 020 136	37 024 278		5	2 117 863	90	92	644
52	Ware, Mass.	8 263	. .	. .	107 481 728	59 778 287		56	294 471	36	. .	. .
53	*Watertown, Mass.*	9 706	. .	. .	. . .	. . .	. . .	. .	. . .	. .	. .	. .
54	Wellesley, Mass.	5 072	4 967	4 929	87 194 763	45 821 571	457 700	53	238 884	47	48	270
55	Whitman, Mass.	6 172	. .	. .	48 661 422	. . .	. . .	. .	133 318	22	. .	. .
56	*Wilmington, Del.*	76 500	. .	. .	2 529 322 860	1 016 936 250		40	. . .	90	. .	. .
57	*Winchendon, Mass.*	5 001	. .	. .	20 542 416	9 696 750		47	57 835	12	28	154
58	*Woburn, Mass.*	14 254	. .	. .	417 435 900	42 572 170		10	1 116 811	80	. .	. .
59	Woonsocket, R. I.	32 500	32 000	32 000	341 074 454	. . .	. . .	. .	933 244	28	29	397
60	*Worcester, Mass.*	118 421	. .	113 217	2 890 601 107	1 489 290 945		52	7 919 455	. .	70	. .
61	*Yonkers, N. Y.*	. . .	. .	. .	1 323 696 099	. . .	. . .	48	3 626 564	76	. .	. .

[1] Nine months. [2] High service only. [3] Estimated average, including summer population. [4] Estimated. [5] Six months.

Number.	Name of City or Town.	1 Kind of Pipe.	2 Size of Pipe. (Inches.)	3 Length Extended During the Year. (Feet.)	4 Length Discontinued During the Year. (Feet.)	5 Total Length in Use. (Miles.)	6 Cost of Repairs per Mile.	7 Number of Leaks per Mile.	8 Length of Pipe Less than 4 In. Diam. (Miles.)	9 Hydrants. Number Added.	10 Hydrants. Total in Use.	11 Gates. Number Added.	12 Gates. Total in Use.	13 Gates. Number less than 4 Inch.	14 Gates. Number of Blow-off Gates.	15 Range of Pressure on Mains at Center. (Pounds.)
1	*Albany, N. Y.*			1 683		129 7				5	808	3	803			
2	*Andover, Mass.*			2 637		25 8				2	196	9				
3	*Arlington, Mass.*	C. I., C. L.	4 – 12	9 754		33 1			0 7	21	326	24	265			
4	Atlantic City, N. J.	C. I.	4 – 20	12 988	1 478	47 6			2 4	51	519				9	
5	Attleboro, Mass.	W. I., C. L., C. I.	1 – 16	5 278		31 6		0 57		12	263					54– 62
6	Bay City, Mich.	C. I., Wyckoff.	3 – 20	10 597	6 349	45 3	$17 32	1 38	0 1	7	413	15	706	3	15	35– 38
7	Billerica, Mass.	C. L.				9 7		0 41			101		84			54–120
8	Boston, Mass.	C. I.	2 – 48	52 949	59 085 [1]	713 4	27 09	0 5	2 1	122	7 606	239	8 910	10		40– 90
9	Brockton, Mass.	W. I., C. L., C. I.	6 – 30	6 987	0	64 5	0 96	0 2		16	608	21	628		22	47– 56
10	Burlington, Vt.	C. L., C. I., W. I.	4 – 30	7 077	3 488	38 0	4 61	0 36	2 7	0	213	23	618	59	12	70– 85
11	Cambridge, Mass.			9 586						23	968	40				
12	Chelsea, Mass.	C. I.	6 – 16	1 728	0	37 8			0 1	6	253	5	399	0	30	48– 50
13	Concord, N. H.	C. L., C. L.	4 – 30	7 530	3 551	60 2				4	267	16	757			
14	*Dover, N. H.*									0	176					
15	*Erie, Pa.*		¾ – 20	18 799		107 2				28	595	95				
16	Essex Junc., Vt.	C. I.	4 – 10	22 000	0	4 2				27	27	15	15	0	5	56– 59
17	Fall River, Mass.	C. I.	6 – 24			87 3				20	954	16	940			80
18	Fitchburg, Mass.	C. I.	2 – 20	6 481		66 6				23	499	12	554			75 L S 155 H S
19	*Geneva, N. Y.*	C. I.	2 – 16	4 172		27 1				15	207	10	250	3		
20	*Haverhill, Mass.*		2 – 24	9 360						3	322	28	770			
21	Holyoke, Mass.	C. I., W. I.	½ – 30	13 476	0	81 6	5 14	0 04	5 9	10	860	34	734	3	30	80–100
22	*Hull, England.*			61 292		208 0				169						
23	*Ipswich, Mass.*		6 – 14	10 438		14 9		0 13		11	137		135			
24	Keene, N. H.	W. I., C. L., C. I.	4 – 24	1 738	0	35 6	3 25	1 5	3 3	1	215	1	358		27	45– 62
26	*Leominster, Mass.*	C. L., C. I.	1½ – 20	11 232		46 1				18	326	30	363			
27	*Lewiston, Me.*									1	173	5				50–110
28	Lowell, Mass.			8 011		127 8				10	1 098	22	1 188			
29	Lynn, Mass.	W. I., C. L., C. I.	2 – 20	8 205		129 4		0 8		8	952	12	966			45– 60
30	Madison, Wis.	C. I.	4 – 16			34 3					169		231			
31	*Manchester, N. H.*	C. L., C. I.	4 – 20	10 032		96 9				6	743	26	910			
32	*Marlboro, Mass.*		4 – 16	0		37 3		0 05	1 4		343		386			

33	Metropolitan W. W. (Owned by Met. W.W.)	C. I., C. L.	6	– 60	13 140	. .	69 8	. .	. .	. .	. .	. .	28	208	. .	. .		. . .
	(Tot. Sup. by Met. W.W.)	C. I., C. L., Kal.	4	– 60	164 000	. .	1360 3	. .	. .	. .	297	11 913	. .	. .	. .	. .		. . .
34	Middleboro, Mass. .	C. I.	4	– 12	4 376	. .	17 0	. .	0	. .	6	120	12	174	. .	6		45– 60
35	Minneapolis, Minn.	C. I., Steel.	1¼	– 50	42 219	0	269 2	. .	0 12	. .	106	3 172	106	2 195	. .	13		. . .
36	Nantucket, Mass. .	C. I.	2	– 8	510	0	7 5	$ 0	0	5 3	0	50	3	66	. .	. .		. . .
38	New Bedford, Mass.	C. I.	4	– 36	12 315	1 061	92 7	24 00	0 16	1 2	15	738	38	1 065	80	95		28– 64
39	New London, Conn.	W. I., C.L., C. I.	4	– 24	8 918	0	50 5	18 71	0 48	3 1	15	258	11	318	. .	30		40– 48
40	Newton, Mass. . .	C. I.	4	– 20	7 071	700	136 6	6 43	0 04	2 9	5	935	11	801	47	380		84
41	Oberlin, Ohio . . .	C. I.	4	– 12	0	0	9 3	0	0	0 3	0	87	1	57	2	2		27– 32
42	Plymouth, Mass. .	C. L., W. I.	2	– 20	6 932	300	37 3	10 87	2	9	2	132	15	349	135	22		. . .
43	Providence, R. I.	C. I.	6	– 36	36 185	3 830	324 6	0 56	0 07	0	32	1 886	68	3 399	0	32		64– 73
	H. P. Fire System	C. I.	12	– 24	. . .	. .	5 6	. .	. .	. .	0	92	. .	31	. .	4		114
44	Quincy, Mass. . .	C. I., Kalamine.	2	– 20	28 100	1 900	84 1	. .	. .	7 1	50	539	82	1 001	. .	. .		78– 85
45	Reading, Mass. . .	C. I.	4	– 12	12 114	0	26 9	0 30	0 04	0	9	140	14	234	0	14		68– 78
47	*Schenectady, N. Y.*	. . .	4	– 12	15 124	. .	40 0	. .	. .	. .	48	469	38	710	. .	. .		. . .
48	Somerville, Mass. .	C. I., C. L.	4	– 20	14 048	. .	. .	3 77	0 2	. .	27 [2]	897 [2]	69	1 203	. .	108		45– 95
49	Springfield, Mass. .	W. I., C. L., C. I.	1	– 36	12 837	5 015	144 7	5 50	0 30	7 7	2	955 [2]	52	1 889	361	89		30– 35 L S 100–120 H S
50	Taunton, Mass. . .	C. I.	4	– 20	6 240	. .	78 3	25 94	0 19	1 9	13	783	7	547	12	54		45
51	Waltham, Mass. . .	C. I., W. I., C. L.	2	– 24	5 778	. .	51 1	3 50	3 00	. .	6	331	27	677	. .	. .		58
52	Ware, Mass. . . .	. . .	1¼	– 12	561	. .	11 5	. .	. .	. .	0	114	1	119	. .	. .		. . .
53	*Watertown, Mass.*	C. L., C. I.	2	– 16	1 707	. .	34 7	. .	0 17	. .	2	337	7	379	. .	. .		. . .
54	Wellesley, Mass. .	C. I.	4	– 12	7 961	0	30 5	0 81	0 3	0 5	14	270	12	214	9	4		70
55	Whitman, Mass. .	C. L., C. I.	1½	– 12	1 895	. .	17 0	. .	0 06	. .	3	151	3	89	. .	. .		65
56	*Wilmington, Del.* .	. . .	.	.	8 597	. .	102 2	. .	. .	. .	18	765	85	. .	. .	. .		. . .
57	*Winchendon, Mass.*	C. I. .	.	.	. .	. .	15 2	. .	. .	. .	7	121	3	158	. .	. .		107
58	*Woburn, Mass.* . .	. . .	.	.	. .	. .	. .	. .	. .	. .	9	352	10	422	. .	. .		. . .
59	Woonsocket, R. I. .	C. I.	4	– 20	3 696	. .	45 8	3 57	0 46	0	8	548	8	456	. .	15		50–120
60	*Worcester, Mass.* .	. . .	2	– 40	17 424	. .	173 5	. .	. .	. .	49	1 763	70	2 432	. .	. .		70 L S 150 H S
61	*Yonkers, N. Y.* . .	. . .	.	.	19 800	. .	74 1	. .	2 71	. .	47	771	43	498	. .	. .		. . .

[1] Not including 10 483 feet taken by the Metropolitan Water Works. [2] Public hydrants only.

1900. — TABLE V. — STATISTICS RELATING TO DISTRIBUTION SYSTEM. — SERVICE PIPES.

Number.	Name of City or Town.	16	17	18	19	20	21	22	23	24	25	26		27	28
		SERVICE PIPE.					SERVICE TAPS.				METERS.			Motors and Elev'tors	
		Kind.	Size. (Inches.)	Extended. (Feet.)	Discontinued. (Feet.)	Total in Use. (Miles.)	Number Added.	Total in Use.	Average Length of Services.	Average Cost of Services.	Number Added.	Now in Use.	Percentage of Services Metered.	Added.	Total in Use.
1	*Albany, N. Y.*										66	2 030			
2	*Andover, Mass.*	C. L., L. L., Tarred, L., C. I.	¾ – 4	2 008		12 1	31	876	73			643	73		
3	*Arlington, Mass.*						76	1 570			5	71	2		
4	Atlantic City, N. J.	C. I., L., G. I., T. L. G. I.	½ – 4				293	4 249			318	3 298	78		
5	Attleboro, Mass.										105	957			2
6	Bay City, Mich.	Lead, W. I., C. I.	⅜ – 8				42	2 201			51	826	37		
7	Billerica, Mass.			2 545			20	205	66		13	67	33		
8	Boston, Mass.	C. I., Lead.	½ – 8	36 500	9 059	460	1 434	87 525	28	$15 28	0	4 516	5	46	665
9	Brockton, Mass.	W. I., L. L., C. L., C. I.	¾ – 8	8 263	252	31 5	135	5 275	60		164	4 300	81		
10	Burlington, Vt.	G. I., C. I., Lead.	½ – 6	1 891	120	18	61	3 350	31	9 01	190	2 311	69	0	35
11	Cambridge, Mass.						158	14 207			270	860	6		
12	Chelsea, Mass.	Lead.	⅝ – 2	1 779	0	31 3	62	6 146	28	15 00	12	104	2	1	7
13	Concord, N. H.			1 475		14 9	57	3 340			95	1 010	30		
14	*Dover, N. H.*	Cement Lined.		1 300		16 7	20	1 813	49			463	26		
15	*Erie, Pa.*		¾ – 6	7 149	537	43 7	378	1 154				270	2		
16	Essex Junc., Vt.	Galv. Iron.	¾ – 2	6 000		1 1	120	96	50	12 00	36	36	37	0	0
17	Fall River, Mass.	Lead.	½ – 2				160	6 943			181	6 544	94		
18	Fitchburg, Mass.	W. I., C. L., C. I.	¾ – 8				73	4 432			103	2 427	55	3	94
19	*Geneva, N. Y.*						158	1 679			319	966	61		
20	*Haverhill, Mass.*						85	5 319			41	563	11		
21	Holyoke, Mass.	C.L., Rubber Lined, Enameled, C.I., L.L., G.I.	⅝ – 4	1 266		13 7	76	3 610	20	16 46	5	210	6	1	96
22	*Hull, England*											789			
23	*Ipswich, Mass.*	Lead, G. I.	¾ – 3	3 382		6 5	30	647			11	138	21		
24	Keene, N. H.	W. I., C. L., G. I., Lead.	¾ – 6	840	0	9 8	28	1 725			9	103	6	0	10
25	*Leicester, Mass.*						14	305							
26	*Leominster, Mass.*	Cement Lined.		6 813			96					394			
27	*Lewiston, Me.*			3 165			31					64			
28	Lowell, Mass.	W. I., Tin L., L. L., Lead.		4 666		7 9	115	10 634			326	5 586	51		
29	Lynn, Mass.	C. L., L. L.	¾ – 4	2 652	489	105 4	191	13 504			235	2 571	19		
30	Madison, Wis.	Lead.				14 0		2 758				2 586	94		

31	*Manchester, N. H.*	. . .	½ – 6	2 627	. .	26 7	97	5 513	. .	. .	173	3 667	67	.	.
32	*Marlboro, Mass.* .	. . .	. .	. .	. .	. .	—45 [2]	2 181	. .	. .	54	1 141	52	.	.
33	{ District suppl'd by Met'politan W. W. }	. . .	. .	. .	. .	. .	1 766	134 496	. .	. .	154	10 385	8	.	.
34	Middleboro, Mass. .	C. I., Lead.	¾ – 3	1 302	. .	9 3	29	820	45	. .	22	349	43	0	7
35	Minneapolis, Minn.	Lead, G. I.	⅞ – 1	. .	. .	. .	. . .	20 064	. .	. .	916	5 030	25	1	20
36	Nantucket, Mass. .	Lead, G. I.	½ – 2	326	74	2 2	32	929	13	$5 25	0	0	0	0	0
37	Nashua, N. H. . .	G. I.	¾ – 2	. .	. .	. .	. .	. .	. .	. .	24	475	.	.	8
38	New Bedford, Mass.	Lead, C. I.	½ – 10	6 558	416	61 1	129	9 280	35	28 33	331	1 429	15	17	116
39	New London, Conn.	W. I., C. L., G. I., Ld., C. I.	½ – 4	1 973	221	11 3	105	3 088	19	11 26	4	229	7	0	17
40	Newton, Mass. . .	Lead, W. I., C. I.	½ – 6	10 624	3 467	79 1	142	7 087	59	23 00	259	6 001	85	0	17
41	Oberlin, Ohio . . .	G. I., Lead.	¾ – 2	. .	. .	. .	29	625	25	8 00	87	392	63	0	0
42	Plymouth, Mass. .	Lead, C. I.	½ – 1	569	. .	6 0	61	1 894	16	5 62	.	. .	.	0	1
43	Providence, R. I. .	Lead, C. I.	½ – 10	. .	. .	. .	598	21 566	. .	. .	689	17 813	83	7	161
44	Quincy, Mass. . .	G. I., Lead, L. L.	⅝ – 3	. .	. .	. .	441	4 330	30	14 00	10	122	3	.	.
45	Reading, Mass. . .	G. I., C. L., L. L., C. I.	¾ – 6	3 652	66	14 1	41	1 057	89	41 95	45	962	91	1	3
46	*Salem, Mass.* . .	. . .	. .	. .	. .	. .	59	. . .	. .	. .	.	185	.	.	4
48	Somerville, Mass. .	Lead, C. L., L. L.	½ – 1½	8 987	. .	65	238	10 291	33	. .	.	202	2	.	8
49	Springfield, Mass. .	Tarred, G. I., C. I.	½ – 6	. .	. .	. .	308	9 764	. .	. .	224	3 122	32	4	230
50	Taunton, Mass. . .	C. L., Tin L.	¾ – 3	5 860	. .	43 3	136	4 502	51	35 41 [3]	99	1 832	41	0	16
51	Waltham, Mass. . .	C. L., W. I., C. I.	¾ – 10	4 334	890	38 6	58	3 285	53	23 46	0	78	2	0	6
52	Ware, Mass. . . .	. . .	. .	. .	. .	. .	11	727	. .	. .	17	735	100	.	.
53	*Watertown, Mass.* .	. . .	. .	. .	. .	. .	52	1 583	. .	. .	213	1 427	90	.	.
54	Wellesley, Mass. . .	C. I., C. L., W. I.	½ – 6	6 100	. .	15 7	42	878	94	13 15 [3]	31	799	91	0	1
55	Whitman, Mass. .	. . .	. .	. .	. .	. .	23	988	. .	. .	.	462	47	.	.
56	*Wilmington, Del.* .	. . .	. .	. .	. .	. .	338	. . .	. .	. .	120	688	.	.	.
57	*Winchendon, Mass.*	. . .	1	. .	. .	. .	58	388	49	. .	.	373	96	.	.
58	*Woburn, Mass.* . .	. . .	. .	. .	. .	. .	27	2 896	. .	. .	3	67	2	.	.
59	Woonsocket, R. I. .	C. I., Lead.	⅝ – 6	901	0	6 3	87	2 193	11	11 38	61	1 899	87	0	12
60	*Worcester, Mass.* .	. . .	. .	14 289	. .	121 2	284	13 292	48	. .	310	12 529	94	8	353
61	*Yonkers, N. Y.* . .	. . .	¼ – 8	. .	. .	. .	. . .	4 968	. .	. .	230	4 852	100	.	.

[1] Estimated. [2] Loss. [3] For current year.

EELS IN WATER WORKS AND THEIR CONTROL.

BY DR. GEORGE W. FIELD, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, BOSTON.

[*An Informal Talk at the Meeting of March 13, 1901.*]

The eel is a good deal like the dog which some compassionate man noticed apparently stranded in a country railroad station, and he asked the baggage master why the dog was there, and where he was going. The baggage master said, "Stranger, I don't know where that dog is going, and he don't know nuther. He has et his tag."

The eel question is similar. It is extremely difficult to get any accurate information in regard to the habits of this animal. We all know and have known eels from boyhood; we all know something about them, and we all know something different. If you interview the fishermen about them you will get almost as many different answers as you ask fishermen. If you ask them if they ever saw a male eel, they will say No. If you ask them how eels breed, they will say they don't know; they must breed some way, but they don't know anything about it. That is the condition which obtains to-day, and that is the condition which obtained eighteen hundred or two thousand years ago. We find old Aristotle describing the eel as "an animal which is neither male nor female, but which generates spontaneously in the mud." You ask a fisherman how eels breed, and the chances are more than even that you will to-day get an answer similar to that. It is really only within three years that we have found out anything about the breeding habits of the eel. I would like very much to turn this into an experience meeting. I will tell you what little is known about eels, and will perhaps give you a hint or two as to what can be done to prevent trouble from them in the water works; and then I will ask you in turn to relate your experiences with eels in various water works, how many of you are troubled by them, to what extent, and so on.

Besides this statement that eels are generated from the mud spontaneously, there is a very current belief among boys, and among

some men, that eels are generated from horsehairs. Perhaps we all have had this idea at one time; I know I did. You have often seen these hairlike worms in the pools and mud puddles, and it is a common belief that those little worms turn into eels. Other people hold that eels are generated from old snake skins and eel skins. Further, it has been suggested that eels pair with the water snakes, and that the young are a cross between a water snake and an eel; but, of course, that is entirely out of the question. In Germany there is in the rivers an eel-like animal which gives birth to living young, and so the Germans refer to that as the mother eel, — *die Aalmutter*, — and regard this one animal as the source of all the eels. Of course this is a confusion of two entirely distinct animals. Then, further, many people say that eels come from other fishes. Of course this is a confusion with the internal parasites, of which all fishes have a great number. They have seen, perhaps, internal parasites in other fishes, and from their shape and perhaps color, have inferred that they are young eels.

It is probably unnecessary to say that there are many species of eels, but it is an interesting fact that where one species of eel is found in fresh water the same species is found in the salt water in that immediate region.

Now, that we may know what we are talking about, I will say that we are talking about the common eel of New England, which is not this one [referring to a specimen]. This is a specimen of the lamprey, which you probably all know, — the large, round-mouthed eel which runs up in the spring, and which is sometimes seen carrying stones to make a nest. This is a very small specimen, which I brought for convenience.

The study of the difference of appearance between the male and female eel is extremely interesting. If you examine a pile of eels in the market, the chances are you will find perhaps ninety-nine out of every one hundred are female eels. In general appearance, the male eel is very much smaller than the female. The full-grown male eel is scarcely ever more than fourteen inches long, whereas the female eel may be much longer, and frequently is as it gets to market. The snout of the male is very much more pointed than that of the female eel. The nose of the female eel is broad and blunt. The color of the male eel is described as deep, darkish green, or even deep black, with a silvery luster, and a whitish belly; while the female has a clearer color, usually of a greenish hue and black, and yellow-

ish on the belly. The male has apparently more pigment, is much blacker than the female, and the female is more yellowish on the belly. The dorsal fin is very much lower and less developed in the male than in the female. But the most marked difference is in the eye. The eye of the male eel is very much larger than the eye of the female eel, and that is apparently associated with the fact that the male eel lives in the deep sea, and never runs in the rivers. It is believed that the male eel spends its entire life in the deep sea, while it is the female eel which runs up the rivers in the spring, when it is perhaps two inches long, and lives in our reservoirs and ponds until the next spring, or later, when it becomes sexually mature, and then runs down to the sea to lay its eggs. It is a question whether it comes back or not. An examination of the female eel indicates that all the eggs mature at the same time, thus differing from many other animals. If you examine other animals you will find some eggs larger than others, tapering down to very small ones, which indicates that the eggs are laid either separately, or in small batches; while in the eel you find them all of the same size, which indicates that all the eggs which the animal is capable of producing during its life are laid at the same time. And, by comparison with other animals where the same condition obtains, the inference is that the animal dies as soon as all the eggs are laid.

It has been definitely settled that the eel lays its eggs like other fish, and does not give birth to living young; neither are eels generated in the mud, as is often believed. Of course you can readily see the basis of the idea in the fact that eels hide themselves in the mud and are found there in various sizes.

Now the development of the eel goes on, as I have said, in the ocean. The eggs are laid there, — they have been found to be about one-fortieth of an inch in diameter; and their development goes on at the expense of the yolk, just as in the case of the hen's egg. The yolk is constantly growing smaller, and the animal itself, which develops from the egg, is constantly growing larger, until, when the yolk disappears, the animal is able to live an independent life. So it is with the eel. I have some photographs here, kindly loaned for this occasion by Dr. C. H. Eigenmann, of the University of Indiana, who made some investigations last summer at the Woods Hole Laboratory of the United States Fish Commission. He succeeded in finding, out in the Gulf Stream off Nantucket, some eggs which he kept in an aquarium, where they developed into eels; and

he has made some photographs,* which I have here marked from one to eight, showing the different stages in the development of this particular eel. I want to say that this is not one of our common eels, but it is very closely related to it; it is certainly an eel, and the belief is that ordinary eels go through practically the same stages, so that for our purposes we may use what information we can get from this as representing the development of the common eel.

You will see [in the photographs] the food yolk on the anterior part of the eel, and notice that when we come down to the fourth stage it has disappeared; and in this condition the animal, swimming free in the surface water, is able to get its own food. Then you will notice in the next figure how the jaws are beginning to develop, and when you get to the eighth figure you will see a very marked development of the head and of the jaw.

Here are some later stages which show fairly well the appearance of the animal as seen under a microscope. You will be able to make out the eel-like characteristics. Then in this third drawing we have a still later stage, when the animal is about a week old. This shows the head magnified, and you will notice particularly the development of the teeth. It has in this young stage very remarkable protruding teeth, three or four on each side, showing that even in these young stages it is very fierce and voracious, destroying other fish. As it develops it loses these teeth, and acquires the small teeth with which you are familiar, perhaps in a practical way.

Until last summer, about all that we knew of the eel in a scientific way was due to Professor Grassi, of the University of Rome, who spent four years in studying the development of this one animal, and who obtained some very remarkable results. Up to Grassi's time there had been described an animal which was long and ribbon-like, represented in Fig. 1 on the accompanying plate, — transparent, with approximately one hundred and fifteen pieces in the backbone. Grassi succeeded in getting specimens of these at Messina, which is a remarkable place for marine life, from the fact that the strong currents throw up there the animals which live on the bottom of the deep sea. Perhaps you know that is the region which Homer described as Scylla and Charybdis, where so many vessels were wrecked. Now Professor Grassi found at that point a considerable number of these fish, which had, until then, been described as an independent

* These photographs could not be obtained for publication. — ED.

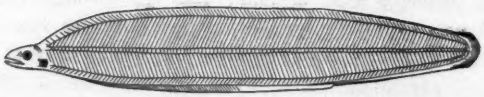


FIG.1.

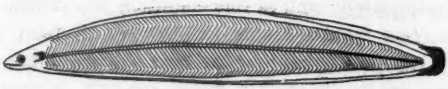


FIG.2.

FIG.3.

FIG.4.

FIG.1-LEPTOCEPHALUS BREVIROSTRIS.
FIG.2-LEPTOCEPHALUS BREVIROSTRIS-LATER STAGE.
FIG.3. ANGUILLA VULGARIS. TRANSITION STAGE.
FIG.4 ANGUILLA VULGARIS DEFINITIVE HABIT. (ELVER)
AFTER GRASSI

[FULL SIZE.]

species. No one then suspected that they were young eels, and they had been given a different name, — *Leptocephalus brevirostris*, — which means, literally translated, the short-nosed thin head. You see he has a small, short head and a long, thin, ribbon-like body.

Professor Grassi kept these in aquaria, and found that instead of increasing in size they took no food and diminished in size, passing through a most remarkable change. In fact, the young eel, which develops from this larva, is as much unlike the ordinary eel as a caterpillar is unlike a butterfly. The change, or metamorphosis, which it undergoes is very much like that undergone by the caterpillar in changing into the butterfly. He found these fish, represented in Fig. 1, at the surface, and also in the stomach of a deep-sea fish, — *Orthagoriscus mola*. Hence it was learned that these animals must live on the bottom of the sea; and when Professor Grassi put them in his aquaria, he found that they burrowed into the mud at the bottom, showing that they live at that time of their lives almost exactly the same as the mature eels. In about a week they had the appearance shown in Fig. 2, a little smaller, though not so very much changed. In the third stage, say perhaps two weeks later, he found that the head was developing, becoming rounder and somewhat shorter. But the shortening was most evident at about a month after hatching, when the conditions were about those shown in Fig. 4.

I have here in bottles some actual specimens of young eels, which were taken at the surface at Pensacola. These were very kindly loaned for the occasion by Professor Garman, of the Agassiz Museum of Zoölogy at Cambridge. I will ask you to look very carefully at these and notice particularly the eel-like head, the length of the body, and the thinness. If they were alive they would be transparent, but now they are coagulated by the alcohol. I will ask you to note particularly the change in the size of the eyes. I said the male eel had larger eyes than the female for the reason that they live in the deep sea; so these larvæ, which live in the deep sea, have larger eyes than the ordinary eels. And you see as the eel develops and comes towards the shore, preparatory to ascending a stream, the eyes diminish in size; that is well shown on the diagram and in the specimens.

Now the eel is, as you know, largely a nocturnal animal, and on dark, stormy nights in March, April, and May, these eels ascend the rivers in vast numbers, when they are between two and three inches

long. You may then see them accumulating just below a waterfall, searching for some way among the stones to work their way up above the obstacle. During all this time they are very ravenous, but they are kept in check very largely by the pickerel, the trout, the bass, and by other carnivorous fishes in the rivers, and, of course, only a small percentage of them get into the ponds. So far as we know, these are all female eels that are running up. Once in the ponds they grow very rapidly, spending most of their time, particularly at night, nosing around among the stones, and in the young stages living on the crustacea, worms, and other animals which live under the stones; then, as they get larger, lying in ambush and darting out for the fishes, until at length, as full-grown eels, they can dispose of very good-sized trout or bass; and, undoubtedly, they kill a great number of valuable food fishes. Of course, in the ponds and reservoirs, they are valuable to a certain extent as scavengers, by destroying a considerable quantity of decaying animal matter.

If, for any reason, these eels are shut off from the ocean and cannot return, they remain in the ponds, increasing in size but never reaching sexual maturity. They would migrate if they could, but if they can't they continue to grow, but apparently never develop eggs. And here is a practical point. If a pond is shut off from the supply of young eels, there is no increase in numbers. The eels which are there increase in size, but after a time, of course, they die from natural causes.

Now let us look for a moment at some of the reasons why there has been so great a lack of knowledge in the life history of this animal. First of all is the remarkable fact that the female descends the streams to lay its eggs, differing in that respect from the fishes with which we are familiar, which run upstream to lay their eggs. Further, the spawning of the eel takes place not in shallow water, not in the ponds and streams where we can readily find the eggs, but in the deep sea; and the eggs that have been found, about a fortieth of an inch in diameter, were floating at the surface one hundred to one hundred and fifty miles from land. And again, the young which come from the eggs are entirely different from the adult, and these larvæ are rarely found at the surface, and in the stomachs of deep-sea fish.

We have, perhaps, gone sufficiently into the life history of the animal. I will only refer to one more point, and that is that the eel puts on a bridal dress. In the spring, when they are migrating to the

sea, they change color. The yellow is replaced by a beautiful silvery-white. The probability is that the eels which are known to fishermen as "silver eels" are the adult or sexually mature females on their way to the sea. In addition to this silvery coloring, there is a great increase in the black color, particularly of the fins. But most remarkable is the fact that their eyes enlarge.

Now just a word in regard to the application of this knowledge of the life history of the eel to practical purposes. During the naturalists' meeting at Baltimore, an engineer of the water works asked me what he could do to take care of the eels. He said they were a great nuisance. They had to stop the machinery about once a week and would take out a barrel or more of eels in various stages of maceration, which had been caught in the machinery; and, in addition, they had to keep men ready to answer emergency calls. I looked at the map of the water supply and inspected the dam, and I saw that there was no obstacle to prevent these eels, two or three inches long, going up in enormous quantities and getting into the pond, and there developing into mature eels. Then at the time when they would go down stream naturally the wasteways are usually closed, and the only way that the eels can respond to this migrating instinct is to go into whatever is open, and in this case, you see, it was the large service main.

Now the suggestion which I have to make is a very simple one, and it has probably already suggested itself to you; that is, that an eel-tight overhang should be made at the wasteway of sufficient height so that they cannot work their way under and cannot get over. Then, if a way to get out is supplied, and there is no way for more eels to get in, it is only a question of a short time when the eel nuisance will be abated, if not entirely done away with. There is no reason, theoretically, why it should not be entirely done away with, if you have an eel-tight overhang at the wasteway. It need not necessarily be very high, for the majority of the eels which go in are only two or three inches long.

Now I should like very much to know something about the experience of you practical men in this line, — how many are troubled with eels. I would be very glad, if any one has any special questions to ask, to attempt to answer them. We don't know very much, after all, about eels, but I should be glad to answer any questions that I can.

DISCUSSION.

MR. D. H. GILDERSON.* I would like to ask Dr. Field how much of an overhang he would suggest. We have had a good deal of trouble in our town. We have one pond that is one hundred and ten feet above the river, and there is only one month in the year that there is any overflow from it. We pumped our reservoir full a year ago last fall, and we did n't happen to use it that year, and when we drew the reservoir down in the spring we found over one hundred eels, ranging from three to nine inches in length.

DR. FIELD. At what time of the year did you draw it down?

MR. GILDERSON. We drew it down in the last of April. I wanted to know how large an overhang you would suggest. It is only from two weeks to four weeks in the year that there is any water running out of this pond.

DR. FIELD. What time of the year is that usually?

MR. GILDERSON. Last year it was along about the first of March, but this year the water is n't up within five feet of running over; it varies in different years.

DR. FIELD. The bulk of this migration takes place here in April and May. In many cases, of course, it is unnecessary to have an overhang, or take any of these precautions, for the reason that the dams on the streams below are effective; and, if there are any water works in this section which are not troubled with eels, the chances are that there are some dams below on the stream which stop the migration of the eels, or it may be that there are other ponds in which the eels can find everything they want, and so they stop there. I think that is probably the case in Brockton, where the eels follow up from the Taunton River and stop in the large ponds below, and do not get up into the reservoirs. Ordinarily, I should say that an overhang of two or three feet would be sufficient to answer all purposes. That would depend, of course, on how difficult it was to make it, but if it is tight at the bottom I don't believe an eel two or three inches long could go much over a foot, or possibly two feet at the most. It seems to me three feet would be amply sufficient. Does that cover your point?

MR. GILDERSON. Yes, sir. I would state, if it will be of any interest to you, that it was Kenoza Lake, at Haverhill, which I have spoken of.

---

*Superintendent, Haverhill, Mass., Water Works.

DR. FIELD. I am glad to know of the case, and I would like very much to hear of other places where there has been trouble.

MR. GEORGE F. CHACE.* I should like to ask Dr. Field a question. I understood him to say that the eels always spawn in deep water of the sea, and not in the ponds?

DR. FIELD. Yes.

MR. CHACE. I should like to know how long it takes one of these young eels to grow to be a foot and a half in length. The reason I ask is because there have been a great many large eels in Elder's Pond in Lakeville, and that pond has had no connection with the sea for at least eight or ten years.

DR. FIELD. There is a parallel case, which is a very interesting one to zoölogists, and that is the old sewers at Rome. You know there is an extensive system of old sewers there, and in them has developed apparently a particular variety of eel. It grows to a certain size and gets no larger; and, being in a sewer where it is dark, it has developed large eyes like the deep-sea fishes. It does not become sexually mature, although it apparently lives for an almost indefinite time. It is generally known, of course, that fishes are relatively long-lived animals. The eels probably enter during floods and may remain for years.

Now with regard to the case at Lakeville, it is apparently somewhat similar to that of the Roman sewers. The eels there probably ave developed, and they may never get any larger, though ordinarily, if there is an abundance of food, as I should think there would be there, they continue to grow until they die from natural causes. Apparently the conditions differ somewhat, but the ordinary rule is that they grow very large and gradually diminish in numbers. The eggs of an eel which spawns this spring, we will say, in the ocean, develop before the next spring into eels two or three inches long, and it is probably that stock which goes up the stream in great numbers. If the eggs are laid this spring, the young will go up next spring. Now the rate at which the eels will grow in any particular pond depends entirely upon the food supply. I have no practical knowledge as to just the rate at which they grow, and I know of no experiments or observations which have been made on their rate of growth, but the probability is that with plenty of food they will grow very rapidly up to a certain size, then growth gradually becom-

* Superintendent, Taunton Water Works.

ing less rapid, and then they may remain at about the same size for an almost indefinite time.

Mr. John C. Chase.* The only thing I have to offer on the eel question is of a historic nature, and treats the subject from the standpoint of a food rather than as an annoying incident of a public water supply.

The Merrimac River was a famous abiding place for the lamprey eel in the early years of the century. They went up the stream in the spring in great numbers, and the inhabitants for miles around the Amoskeag Falls in Derryfield, now Manchester, resorted there to catch and salt them for future consumption, and they went by the name of "Derryfield beef."

The poet of the centennial celebration of the incorporation of the town, held a half century ago, alludes to them as follows: —

"For I cannot give e'en a short address
On my fathers' home, their woes, their weal,
And omit the claims of the squirming *eel*.

"'Ignoble theme!' does the critic say? —
But what care I for his sneering bray?
In my boyhood's days upon eels I fed,
And as now to you, I a banquet spread
Of such simple food as the past reveals,
I invite you now to a dish of eels.

* * * * * * *

"Our fathers treasured the slimy prize;
They loved the eel as their very eyes;
And of one 't is said, with a slander rife,
For a string of eels he sold his wife!

"From the eels they formed their food in chief,
And eels were called the 'Derryfield beef'!
And the marks of eels were so plain to trace,
That the children looked like eels in the face;
And before they walked — it is well confirmed,
That the children never crept but *squirmed*.

"Such a mighty power did the squirmers wield
O'er the goodly men of old Derryfield,
It was often said that their only care,
And their only wish, and their only prayer,
For the present world and the world to come,
Was *a string of eels and a jug of rum!*"

The building of dams for the development of the water power of the river has put an end to the running up of the eels, and I under-

*Civil Engineer, Derry, N. H.

stand that at the present time neither eels nor rum are on the bills of fare at Manchester.

Mr. J. C. Hammond, Jr.* Some thirty years ago we had a great deal of trouble with eels in our reservoir, and the turbine wheels in the mills would fill so as to stop the mills. I remember once we took one out of a three-inch pipe in the street which entirely filled the pipe, and completely shut off the water. Of late years we have had no trouble with them, and I think that now, after listening to Dr. Field, I understand the explanation of it. In the Sixties we rebuilt our dam, and the water was very low, so the gate was not closed at all, and there was ample opportunity for eels or anything else to go from the lower pond into the main pond, and there are few if any there now. There are no eels caught in the pond, and we don't see any there, so they must have gone out, when they had a chance to, a great many years ago.

We used to leave our gate open about an inch and a half at night, so as to keep the ponds below full in case of fire. The man in charge of the gate went up there one morning and found the pond next below the dam entirely dry. He was very sure he had left the gate as usual, and upon raising it the water started, and when he looked down into the pond below he saw an enormous eel there. He *said* it was three or four feet long. He did n't catch it, and that is perhaps the reason he said it was so large; but, at any rate, it was big enough to have filled the inch-and-a-half opening in the gate, and shut the water entirely off. I presume that it was one of the old settlers.

Mr. Harry L. Thomas.† There is something in this question that interests me very much. We have had more or less trouble with eels, and, although we have sometimes thought we had gotten rid of them, they would came again. I have always taken it for granted that the eels went into the main when they were very small — of course they must be small in order to get through the screens, which have, perhaps, a quarter or three sixteenths inch mesh. So far as I know, it is quite impossible for any of the young eels to come up and get into our pond, and I have wondered, if that is the case, whether they would not in time entirely disappear from the system. I would like to ask if it is possible for eels to die in the mains from any cause? I presume others have had the same complaint, but once in a while, when a consumer thinks he is getting poor water, he comes to the office and says it

* Treasurer, Aqueduct Company, Rockville, Conn.
† Assistant Superintendent, Hingham Water Works.

tastes as though there were dead eels in the pipe. We have never been sufficiently familiar with the subject to be able to say whether there were dead eels there or not, and I have often wondered whether it is possible that they died a natural death there.

DR. FIELD. I think it is very probable they die a natural death, or very likely from starvation, after getting lodged in a small pipe. In regard to the other point, it seems to me probable that you will, in a very short time, get rid of eels if you are absolutely certain that there is no way for the small ones to get into the pond. I think that while it is possible that they may increase in size somewhat in the mains, the chances are they would n't grow a great deal. Can you tell how large the eels have been that you have found in the main?

MR. THOMAS. They bother us the most in certain localities. Apparently as they are going by a corporation the suction through the service will sometimes knuckle them into it. Our method of procedure then is to put a force pump on the service faucet, open the hydrant beyond, and force them out. We are generally successful in doing that, and we have taken out some, that is, that are from twelve to sixteen inches long. We have blown them out of the hydrant, and they would be alive when they came out.

DR. FIELD. I should hardly call an eel of that size a large eel, as I would use the term, and I think it very probable they may have grown to that size in the pipe. It would depend entirely on how much food they got. Most of these animals, as I say, grow according to the amount of food they get. With abundance of food they grow rapidly; with a little food they grow very slowly, and I can't tell how long it would take them to grow to the size you mention. Do you know anything about the conditions, how long they had probably been there, or how long since it has been impossible for any eels to get into the pond?

MR. THOMAS. That I cannot say.

DR. FIELD. Points like that would be extremely valuable to know about in solving this question, and, if you can find any data, I would be more than obliged to you if you would give me the information.

MR. THOMAS. I may say that it occurs to me now that the calls to blow eels out of the services and to clean out our eel-traps seem to have been less frequent of late. In the two or three particular localities where we put in eel-traps to catch the eels alive, we used to visit them quite frequently, and find them almost full at times;

now we go there less frequently, and we have fewer calls to blow out eels from the service.

DR. FIELD. How long have your water works been in operation?

MR. THOMAS. Twenty-one years.

DR. FIELD. Have there been any special changes made in the wasteway lately?

MR. THOMAS. The pipes from our gatehouse are just the same as always.

DR. FIELD. There may have been certain conditions which have brought about the difference in the number of eels at various times. If, for example, during March, April, and May the water was running to waste in any particular year, there would be a chance in that year for the eels to run in; and, if the next year the water was not running out at that time, eels could not get in; and so it might happen that on that account the number of eels noticed in one year would be greater than in other years.

MR. CHARLES W. SHERMAN.* I should like to ask Dr. Field whether the polyzoa and similar organisms, which form a quite noticeable slimy coating on the interior of the pipes in many supplies, would be a suitable food material for eels?

DR. FIELD. I should say not. Eels are purely carnivorous, so far as I know. Perhaps the main source of food for the larger eels, if there are a great number of eels in the pipes, would be smaller eels and small fish.

MR. LEONARD METCALF.† I should like to ask Dr. Field in regard to the period of time within which eels, in the natural course of events, in an open stream, would return to the sea. He said that the eggs which were laid one year would develop so that the small eels would perhaps go up next spring. Now in an unobstructed stream, upon which there were no dams, and along which there were ponds in which the eels could get liberal food supply, when would you expect them to return to the sea?

DR. FIELD. That would depend on the amount of food they had.

MR. METCALF. Suppose they had ample food in a pond, would they return the next year?

DR. FIELD. The probability is they would return the next year.

MR. METCALF. As I understand it, they would return to the sea, lay their eggs there and die.

---

*Civil Engineer, Metropolitan Water Works, Boston, Mass.

†Civil Engineer, Boston, Mass.

DR. FIELD. It is supposed so, arguing from analogy. Similar animals which deposit all their eggs at one time then die; and further, no sexually mature eels have been reported as running up in any large numbers. There is a migration in the fall, in certain regions at least, of the eels which come from salt water and run into the brackish ponds, so common along our shores, and locate themselves in the mud and remain there hibernating. You probably have seen the fishermen spearing them through the ice, prodding their spears down into the mud. Have I covered your point sufficiently?

MR. METCALF. Yes, sir.

MR. RICHARD A. HALE.* At Lawrence there is quite an extensive migration of lamprey eels every season, coming up the fishway, along in May and June. Along the later part of June the ordinary silver eel is noticed, four or five inches long. I think the quantity has been slightly decreasing from year to year. There has been more or less trouble at the mills on account of the eels interfering with the wheels, but of late years there has n't been so much difficulty, because the iron racks have been arranged a little closer together and no openings have been left through which the eels could crowd. There have been cases where the eels have got in and filled up the wheel so completely that it has been necessary to stop the mill in order to clean them out. Later in the season I have often noticed many small ordinary silver eels, two or three inches in length, about the wheel pits and the dam, or wherever there is any moisture, and they will climb up perhaps five or six feet above the water. I don't know as there is any limit to their climbing; they seem to climb as long as there is any moisture.

DR. FIELD. An overhang is practically the only thing which will stop them.

MR. HALE. The overhang at the crest of the dam would prevent them going up over the flashboards. On the retaining walls along the river it is very noticeable that where there is any moisture they gather and climb up. I suppose these are the ordinary silver eels, which grow to a larger size and possibly go up the fishway later. Along in the fall there is quite an extended migration down the river, and the Frenchmen catch them and salt them for the winter.

DR. FIELD. Are these the common eels or the lamprey?

MR. HALE. Almost entirely the common eels. I think Professor

* Civil Engineer, The Essex Company, Lawrence, Mass.

Sedgwick has obtained a supply of lamprey eels from Lawrence, and perhaps he can say something about them.

DR. FIELD. It is a well-known place for them, and a great many of our students get their supply for dissection from Lawrence, through the kindness of the officials there.

A MEMBER. I remember some seventeen or eighteen years ago, at the time my father had charge of the works I am connected with now, he set a line out at the station one evening; and the next morning, when the engineer and I arrived, we found him in the pumping station, covered with slime from head to foot, but he had an eel which was probably over three feet long, and I should say it was as big round as my arm. Father had its head screwed in the vise and was getting the hook out of its mouth.

I have noticed, when we did have eels in our works some time ago, we always got them at points where there was the lowest pressure. We could go to a certain point and open a hydrant and draw practically all eels out of the main, getting a bushel out of one hydrant, sometimes.

A MEMBER. Will eels burrow into the ground any distance below the water line?

DR. FIELD. Probably not into anything which is very firm. They ordinarily burrow in the mud, and they will overturn a good sized stone by burrowing under it. They are exceedingly strong. I doubt, very much, if they would burrow into a firm bank so far as to do any damage at all.

MR. GEORGE W. TRAVIS.* I once saw an eel caught in Lake Cochituate which weighed seven pounds; I don't know the length. I saw another caught through the ice in front of my pumping station this winter, about three weeks ago, which weighed five pounds. I think we have never had any trouble with the eels in our pipes.

*Superintendent, Natick Water Works.

THE APPORTIONMENT OF CHARGES FOR PRIVATE FIRE PROTECTION, AND THE MEANS OF CONTROLLING THE SUPPLY FOR SUCH SERVICE.

[*Topical Discussion at the Meetings of February 13 and March 3, 1901; the regulations of various cities; and preliminary report of a Committee appointed to consider this subject, presented September 18, 1901.*]

President Crandall called upon Mr. J. C. Hammond, Jr., of Rockville, Conn., to open the discussion.

Mr. Hammond. Mr. President, I did not come here expecting to open the discussion upon this subject, or prepared to say anything which might be of value to others, but rather hoping that I might learn something of benefit to myself. However, as you have called upon me, I will say that we have in our place a private water company which furnishes water for the mills and also for domestic purposes. We make a charge for supplying water for fire purposes, for sprinklers, and, unfortunately, each one of the mills we supply has a different idea of what the others ought to pay and what he ought to pay; and I, not being a stockholder or director, am a sort of a fender, as it were, between the dock and the steamboat, and I thought I would come here to-day to see if I could n't get another layer of cork on me — in other words, some information. There are three ways of making a charge that I have thought of. One way would be, so much per square foot of floor space; another, so much apiece for sprinkler-heads; and a third method, a percentage on the amount of insurance carried. The objection to the first plan is that some of these mills have a large amount of floor space which is at times used for storage and at other times is unoccupied, while in other mills the floor space is filled with valuable machinery, so that a charge based on floor surface would not be just. The objection to the second plan appears when you want to protect the out-buildings (which may be filled with stock at times) with sprinklers, for there is no great value there even then as compared with a mill which is full of valuable machinery. By following the third plan, that is, charging a certain per cent. on the amount of insurance carried, a man would then pay for the protection he asked for.

I have been writing letters to different water companies, and I find nobody who seems to have had any experience. Apparently the water companies don't want to own up. One of our cotton mills was paying an extravagant rate for insurance, two or three per cent., and the factory insurance people came along and said, "Now, if you will put in sprinkler apparatus we will reduce your rate," and they have got it now down to one per cent., I think; and I know of one company which paid back 90 per cent. in dividends, so that the cost of insurance in such case is only one tenth of one per cent.

Now, if the mills get that benefit in insurance, they get it because we furnish the water. But some of them say, "We don't use the water: it is simply there." Well, my neighbor puts in a telephone, and he says, "Some day if I use it I will pay the same as I would pay at the office." But who is going to pay for it the other three hundred and sixty-four days? It is the same way with our water. They have hydrants in the yard, they have the benefit of sprinkler protection, and why should n't they pay us for it? Our city government pays us twenty dollars a year for a hydrant. We have practically the third system of water works which has been put in since 1846. The first one, which was put in mainly by the mills, never paid a dividend; in 1866 we had four or five hundred dollars in the savings bank and a lot of old rotten cement pipe, and we put in a new system then. The present system was installed in 1893–94. Now, suppose we laid our present twenty-inch main down through the city, and had but a few customers, — as would be the case in any town when it first establishes water works, — and connected up all these mills with sprinklers, and they said, "We don't use the water and we won't pay anything." How would we come out in fifty years when we had to put in another main? Each mill pays one hundred dollars now, and there is no more equity in it than for some of you gentlemen to pay one dollar and a half for your dinner and I pay seventy-five cents for mine, if you and I receive the same fare.

I want to be advised. Some of you say, "We don't make any charge"; but ours is a private corporation. Many cities which have their own water works have a system of keeping a separate account with the water works, and the city pays for hydrants. Now, why should n't the mills pay for water for sprinklers, even if they don't use them except in case of fire?

Mr. Charles K. Walker.* I am glad Mr. Hammond has brought

*Superintendent, Manchester, N. H., Water Works.

this matter up, because I have had some experience myself. The mills have this fire service put in so they can protect themselves, but they don't pay anything for it, and they are awfully apt to tap it. There is nothing fair about that. One of these insurance fellows came around my way the other day, and they were going to put in a pump, so as to be sure, he said. Well, we had our pipes in the mill, and they had something they were not paying for, but they said, "Now, we want to put in a pump and pump out of the river, and we are going to have a signal to display when your pressure is on, and when the flag is down we are pumping." I said, "No, we are not going to do any more of this business. We are going to have a meter, and you must pay for what water you use, whether it is in the pipes you have got around the mill or in the pump. We don't propose to pump water for you to put through your pipes when your pump don't work. We want to know how much water you use." They said they did n't use any, but still they agreed to put on a meter. Whether they will actually do it or not I don't know, but I told them they must n't touch the water if they don't. They ought to pay something for water when they are stealing it. There is no way to do but to put on a meter where the pipe goes into the mill, and if they use the water in any way, shape, or manner, they ought to pay for it.

I think they ought to pay for the protection, but they don't; the city says, "You can have the water, if you don't use it, so as to protect yourself against fire." The insurance folks want it, and they don't care how much you do for them. I find corporations are about the same as individuals; they want to get this thing as cheap as they can, and I think the insurance folks do, too. You are on the right track, Mr. Hammond, and I think you ought to make them pay. I could talk a long time on this subject, but I can't stop any longer now. I hope this question will be discussed and ventilated right here, because we all want to know what to do.

MR. E. V. FRENCH.* I am very glad, Mr. President, that Professor Niles has told us this afternoon of the great benefit of difference of opinion, for I am afraid I shall differ very much in what I shall say from Mr. Walker and Mr. Hammond; and, if we had n't been told how beneficial differences are, we might possibly be troubled about it.

Representing the underwriting side of this question, I appreciate

* Inspector, Associated Factory Mutual Insurance Companies.

very much what Mr. Walker has said, and it has seemed to me that when we come to discuss the matter there was no better way of doing it than to assume some case which would be a fairly typical one.

Now, suppose we take a certain town and, we will say, there are two manufacturing plants in the town, valued at about five hundred thousand dollars each. Mr. Hammond could easily find two such in Rockville. The manager of one of these plants thinks it desirable to depend entirely on city protection against fire, the city steamers and the public water department, and he does so. The manager of the other plant equips his establishment with automatic sprinklers, puts in a pump, and all those other things which Mr. Walker has told us the insurance inspectors delight to look over, and he wants water and asks the town for an eight-inch connection. Generally he is not at all modest, and he may ask for a ten-inch, and perhaps it is given to him. There is some discussion, very likely, at the time, as to how he ought to pay for it, but possibly he pays nothing.

Well, time goes on, and by and by a fire starts in the first plant. It happens to start, we will say, as fires so often do, in the interior, in the worst part of the establishment. Perchance it is a windy night. The alarm is given immediately; the town steamers — perhaps there are two of them — come down, the town fire department rallies, and a very hard fight is put up, but the fire lasts from midnight until well into the next day. The town steamers are worked for all they are worth, and very likely some repairs are found necessary for at least one of them after the fire; a good deal of hose is ruined, and one or two ladders are burned. The next day the fire is talked over, and everybody is very glad that it was stopped as well as it was. It may be that two thirds of the plant has been wiped out, but something has been saved, and the fire was prevented from spreading. Every one is glad, and no one doubts for an instant that it was the *duty* of the public fire department to pump thousands and thousands of gallons of water an hour on to the fire, and keep it up for ten or twelve hours.

The partial destruction of the plant very likely is a serious blow to the town. It is not at all impossible that changed conditions of manufacture make it desirable for the concern to build elsewhere when the question comes up of starting all over again. If they don't do that, which of course is the worst case we could suppose, quite likely it is several months before the plant is put into shape again, and three or four hundred, perhaps more, operatives are out of work for that

time. Quite likely many of them feel that they cannot wait these three or four months in idleness, and they go off to some other place. In all this the town is a direct loser, first from the wear and tear of fire apparatus; and second, and to a much larger extent, from the loss or temporary stopping of business of importance to the prosperity of the town. Still, probably no one suggests that the man ought to have put in any protection of his own. It is the *duty* of the town to put out fires; a man pays his taxes for this very thing, people say; and very likely the outcome of the whole thing is that another steamer is considered necessary, and the town buys it and spends a considerable sum of money each year in maintaining it.

Now take the other case. Suppose a fire occurs in the other plant, which is sprinklered throughout, has a good connection with the town water and a good pump. The experience of every underwriting organization in the country goes to show that the chance of a bad fire in such a protected plant is very, very much less than in the first plant. Probably a fire of the kind starting in the first case supposed in this illustration simply results in ten or fifteen sprinklers opening, and the mill fire pump running for a little while; very likely the public alarm is given, the firemen jump out of their beds, and when they get down to the mill find that the mill apparatus has been working, a few thousand gallons of water have been used, and the fire has been extinguished without any appreciable wear and tear of the fire department apparatus; and the next morning everything is running in the mill as usual. No one thinks much of anything about it; it is taken as matter of course, just as things were in the first case.

Now, is n't it fair to ask whether in this case it was not good business policy for that town to allow the manager, who wanted to protect his plant, a liberal and free connection so he could have water for the sprinklers? We all know that there is nothing better for a sprinkler supply than a good public water system, with its constant care, its necessity of being kept in service every minute, and generally its much larger capacity and higher pressure than would be available from any private tank. So, looking at it from that standpoint, we see that a man who spends very likely $15 000 for his sprinkler and pump equipment — and that would not be an excessive figure for a $500 000 plant — is really asking of the town a great deal less than a man who gets the fire department down there some night to try to put out a fire in his plant, and finally loses the plant.

It would seem, therefore, as if simple, ordinary, everyday business policy would indicate that it was the best thing for a town to grant to mills with protection a liberal water supply for fire purposes, and grant it without any annual charge whatever.

The minute you charge a man so much a sprinkler and so much a hydrant, just that minute there is a tendency for him to use one hydrant where he ought to have three and to want one sprinkler where he needs several. The whole effect of such a ruling by the water department is to scale down fire protection, which it is in every way, it seems to me, for the interest of the town itself that the man should put in; and he puts it in at his own cost, too.

Just one word on the question of quietly taking water for manufacturing purposes from fire pipes and paying nothing for it. We believe that the best arrangement is to have the fire pipes absolutely and entirely separate from the supply used for domestic purposes. We advise it and always lay out systems in this way. The idea is that the fire system shall have no draft of water through it normally, shall simply stand with open gates, ready to pour a deluge of water upon a fire the minute a sprinkler opens, or the instant a lone watchman at night takes a line of hose from a standpipe or hydrant, and be able to extinguish a fire before the pumps can be started. We do recommend that another connection, of any size needed, and generally much smaller than the fire connection, be taken in and metered, if desired, — generally it would be desired, — and that from that second connection *all* the water used for boilers, closets, and all purposes except fire be drawn. Then we always urge that the fire service connection be left unmetered. We all know that meters somewhat obstruct the service, and some of them may under possible conditions of clogging obstruct it very seriously; and we have therefore felt that it was very desirable to have the freest possible connection for the fire system, so as to get a good supply of water and get it right off. Waiting to open any valves in meter by-passes or anything of that kind is absolutely out of the question when you are talking about *automatic* sprinkler protection.

Now, going a little further, and taking up the question of private water companies, it is a little harder to deal with them in this way. The company naturally wants income; that is what it is in business for. But I think if we agree in the idea that it is good policy for any town to keep its manufacturing industries in the town and prevent them from burning up, by aiding them from the public

water supply, then I think we shall be irresistibly led to the conclusion that it is equally the duty of a town supplied with water by a private water company to compensate that private company, if necessary, out of the fire department funds of the town, for any cost which they found they had to bear on account of a connection into a private sprinkler system. This may seem a little radical, and we appreciate that it would be difficult to bring about in many cases, but it seems to me to be the only logical conclusion. It simply means this, going back to our assumed case, that if the unprotected manufacturing plant, being an important industry in the town, had asked the town to put three or four hydrants on adjacent streets, and pay a private water company, assuming there was one, thirty or forty dollars a year for each of them, the town would undoubtedly have granted that request, and would have paid the water company for those hydrants, and nobody would have thought anything about it; or if they did they would have said, "Of course we want to protect that plant." Now, if that man himself puts in apparatus, and simply asks for a connection through which a lesser amount of water will do immensely more good, the proper thing to do is, if there is any charge, to make it to the fire department of the town, which is in duty bound to protect that risk, and which department really should be glad of such assistance as private apparatus gives.

There is another point to think of, perhaps, in this connection. Sprinklers and other protective equipment, such as private pumps and hydrants in a large establishment, are not only useful in preventing that establishment from burning, but they are extremely useful in preventing conflagrations. They do this first by making it generally impossible for a small fire to become a large one; and, secondly, they do it by making it very unlikely that a protected plant will burn rapidly. Sprinklers in a protected building, even if that building is threatened by a severe fire in an adjoining building, will generally hold the fire; they very frequently will keep it from getting in, and when they do not do that they will generally make the sprinklered building so slow burning as to give ample time for the fire department to rally. I happened to be in Boston a few years ago, when the Ames and Brown-Durrell buildings were burning, on Summer and Kingston streets. I wanted to see what was going on, and so got on top of the building opposite the Brown-Durrell building on Kingston Street. It was a rapid fire, you will remember, and some of the people in the buildings did n't get out. Finally the flames beat

against the Brown-Durrell building, which was right across Kingston Street from the building I was on. Everybody noticed that the Brown-Durrell building burned slowly. People did n't know at the time why it was, but after the fire it was learned that the building was sprinklered. The fire which entered the Brown-Durrell building was fed outside by such an enormous mass of material that the sprinklers inside could not cope with it entirely, but they checked it, and there were about five minutes when it was a question whether the fire would get across Kingston Street or not. The glass in the windows of the building on which I was had begun to crack with the heat, and there were not sufficient hose streams in the street; but during that five minutes, when the sprinklers were retarding the fire, the firemen were rallying, the out-of-town apparatus and reserve apparatus were arriving, and at the end of that time five or six hose streams were brought to bear against the building and carried the day, stopping the fire at that point. If that building had n't been sprinklered, and if that critical moment in the fire had occurred fifteen minutes earlier, the fire would have gone across Kingston Street without the slightest doubt, and would have gone on. That is a case where the expenditure by the Brown-Durrell people of several thousand dollars for sprinkler protection, fed by a free city connection, and encouraged by the knowledge that if they put in that protection they would not be called upon to bear any further expense, undoubtedly saved the city a great deal of money. So, in a crowded district, or where there is a conflagration hazard, it would seem as if sprinklers were a good business investment, and a *free* supply of water to them the very best thing for a city or town to grant.

Again, if we go to a place where the water department keeps separate records, and is an absolutely independent department, the same thing applies that applies in a private company. It seems that if any annual charge is made by the water department for a connection with the city mains, that charge properly should be borne by the fire department; and I think it is the case in some cities that the fire department pays the water department so much a hydrant. I think the point is clear, that this matter of supply for fire purposes is a fire matter, not a water matter; and if any charges have to be made, it seems to me they should come out of the money which towns and cities freely and willingly appropriate to prevent the loss of property by fire.

I have put together a few figures which I think will be of interest,

simply to show the importance of sprinklers. In the Factory Mutual Companies there was last year an average of about $900 000 000 worth of property at risk, and there were about 450 fires, giving a loss of $550 000. This property is sprinklered in all the manufacturing parts, and in all rooms where there is moving machinery; in fact, practically throughout, except in some storehouses, rolling mills, and foundries. Of the 450 fires, 378 had a loss of less than $1 000 each, 59 less than $10 000, and only 12 over $10 000. Now, when we remember that textile mills form a large part of this property, many of them working cotton, we see what protection does.

Considering those fires which cost over $10 000 — in one the sprinklers were shut off by accident; in another the public fire department put hose streams in after the fire was really subdued, and made a very large water loss; in a third case the fire was in a jute storehouse, jute being very subject to water loss, and the water went down through several stories, making a heavy water damage; in a fourth case the gas connection broke near the meter, and gas came out and played against the ceiling for over an hour; there was no outside cock which could be found, and the gas was n't shut off until the gas men came and dug up the street and turned off the gas with a monkey-wrench, and all that time the water was pouring into the building, but the sprinklers held the fire in check. Eight of the twelve fires causing more than $10 000 loss were in unsprinklered storehouses, foundries, or rolling mills. So I think we have very clear proof of what protection does; and I think we can safely say that when a town invests its money in a water department, and allows the free use of that water on private fire protective apparatus, under proper restrictions, it is doing something which will give the protection it desires.

One more thing. I wrote to a number of superintendents and I have received replies very promptly, for all of which I am very much obliged. The reports from thirty-eight towns and cities showed that in thirty-one no charge whatever is made for water for fire purposes; a charge is made for laying the fire service connection, but no annual charge for water or for having the service ready to be used in case of fire. In seven a charge is made, but in six of those cases there were private companies. My inquiries covered New England, New York, and New Jersey, as far as I could make them in the very short time I had, and I think that the returns are a fair indication, perhaps, of what the general practice is.

Just one more word as to this matter of water being improperly

used for mill purposes through fire connections. We have hoped that some method might be found to obviate this other than by putting meters on the fire supplies. We have always tried to get rid of meters. One way which has been adopted, I think with a good deal of success, in Providence, and is being taken up in New Bedford and Fall River and in some other places, is to seal all the hydrants, using an ordinary lead seal such as is used on freight cars, and then having it understood that these shall not be broken except in case of fire, and then the water department shall be notified within perhaps twenty-four hours. When insurance inspectors wish to test the public water supply, about once a year, as is the practice, the water department furnishes a man to go with the inspector at a time agreed upon, and the seal is broken and resealed, and in some cases a moderate charge is made for the man's time. That, I think, is very fair and reasonable, and the only objection to it is that it prevents a mill manager from exercising his fire department here and there in the yard on a Saturday afternoon and putting on a few streams from his hydrants and using his pump; but the gain, where it is necessary to have some protection, is far more than the loss.

Of course where some type of metering device must be used, we have all been interested in some of the by-pass methods which Mr. Crandall has told us about, and which we and also some of the water meter people have been experimenting with. On this matter we hope a little later to have some data of interest. But we prefer to get along without anything if we can, and to try to lay out a fire system so simply that all the pipes can easily be traced, and the water department inspector can make sure that there are no improper connections, and then if it is believed that further precaution is necessary you can seal the hydrants and sprinkler drip-valves. But we very much hope that the policy of annually charging for services used for fire purposes will not become general; and I think we can all see that should it become so it would tend to discourage the investment of private money in private protective equipments, which are very much more efficient than anything which can be secured from outside hose streams only.

MR. HAMMOND. I made no complaint about stealing water — you may possibly know the location where I live, being an insurance man. Each mill has direct connection for fire streams without a meter, and they have a separate system metered. They are all will-

ing to pay, but the question is, What is a fair basis for us to charge on? Bear in mind that our corporation is a private company, and we give the mills all the hydrants they want; but I say it is not a parallel case to a public water supply of a city, for they can tax the citizens to make up for any deficiency.

THE PRESIDENT. I think it would be well to continue this discussion at our next meeting. I have no doubt many of you would like to make some remarks on this subject, and if there is no objection we will have it on our program again at that time.

[Continuation of Discussion, March 3, 1901.]

PRESIDENT F. H. CRANDALL.* At our February meeting, the discussion of the subject "Charges for Private Fire Pipes" had progressed but a short way when, owing to the lateness of the hour, it became necessary to adjourn.

A case was then presented where the cost and value of protection afforded by private fire pipes was recognized. There was no difference of opinion as to who were the parties benefited, nor was there any desire to assess the cost of the protection upon others than those directly benefited. In short, the mill people, who derive their fire protection, both public and private, from the water works (for the former, the town pays at the rate of twenty dollars a hydrant) are the owners of the works. They have become convinced of the necessity of increasing the receipts from private fire protection, and are considering how the increase can be most equably apportioned.

A member, who had troubles of his own, spoke briefly and feelingly in regard to furnishing water to pipes supposed to be used for fire purposes only.

Another member, presenting the insurers' view of the case, called attention to the facts that every dollar paid by a mill corporation to any one else for fire protection lessened by just so much the amount which that corporation could be induced to invest in insurance premiums and improved fire protective appliances; that fire pipes might be kept entirely independent of, and free from, connection with other pipes; and that, if deemed necessary, assurance in regard to the use of such pipes for no other than fire purposes might be required, there being no mechanical obstacle in the way of secur-

* Superintendent, Burlington, Vt., Water Works.

ing information on that point without detriment to the interests of either of the parties interested.

The advantage to the public in general, which may and occasionally does result from the presence of automatic sprinklers, was clearly and forcibly stated. The damage which occasionally results from their presence, or, to be more accurate, the damage which occasionally results from the improper installation of such plants, was not mentioned. Neither was there much said in regard to the general tendency to meter fire pipes at the street line, as evinced by the practice in Philadelphia, Pawtucket, Portland, Norwich, and other cities. Nor was there much said in regard to rates charged for such service, as in Providence, Milwaukee, San Francisco, Newark, and other places, where the propriety of making assessment for such service is recognized.

Experience everywhere indicates that the improper use of services, relative to the use of which no means of securing reliable information is provided, is a natural consequence of their existence, and must be recognized as one of the conditions of the situation. Such use of such pipes is condoned, if not abetted and encouraged, by the community furnishing an unmetered and otherwise unsafeguarded supply.

The teacher who each night requests those of his pupils who have broken no rule to rise, and who at the end of the week rewards those who have risen each night, has little to say for himself when taxed with offering a premium on prevarication.

The housekeeper who, on account of shutting a hungry cat in the pantry, suffers considerable loss, finds small consolation in blaming the cat.

The water department, placing an unmetered and otherwise unsafeguarded supply on the premises of a taker, finds itself quite similarly situated.

Except in the case of public water works furnishing water for private fire protection, it is not as yet customary to rely upon customers to help themselves, and afterwards to tender a proper equivalent.

The fairness of any assessment, it goes without saying, is dependent upon the accurate determination of the benefit for which assessment is made. Schedule assessment for private fire protection may, under favoring circumstances, be based upon the number of automatic sprinkler-heads and other openings supplied; upon the saving in in-

surance secured, or upon the amount of insurance carried. Either of these methods involves going to the customer for data upon which to make out his bill.

Over such methods, a method the data for which is to be found in the books of the water department, and which involves neither espionage nor reliance upon outside information, presents manifest advantages. The size of the branch and the class of service rendered together furnish a basis for such assessment.

The cost of furnishing water for fire purposes only to pipes in which a pressure slightly in excess of the water-works pressure is maintained, with a gong to automatically give warning of a drop of pressure, is very different from that of furnishing the same service to pipes on which there are no such appliances for the immediate detection of leakage or withdrawal of water.

The value as well as the cost of protection afforded by a properly safeguarded system of automatic sprinklers, by a system of hydrant or standpipe openings with hose attached, or by the latter system without hose attached, is in each case different.

To assess the benefit derived from private fire pipes, the first requisite is assurance in regard to the method of their use. If it cannot otherwise be clearly shown that they are used for no other than fire purposes, a meter rate with minimum clause, based on the size of the service, offers about the only equable method of assessment. This method is evidently growing in favor, as are meters in general wherever difficulty is encountered in arriving at an equable schedule assessment. The metering of such service without detriment to the interests of either insurer or insured, so far as interruption of water supply is concerned, is merely a matter of a few dollars. The inability of large meters to measure very small streams a small outlay also suffices to overcome.

It may to some, but not, I think, to the insurance people, seem an error to say that the insurance companies are more interested than the water companies in the prevention of improper construction and use of private fire pipes.

It is annoying to the water-works people to be obliged, yielding to the demands of influential taxpayers and insurance people, to grant applications for service calculated to place in jeopardy large interests. When the automatic sprinkler system, after having fulfilled its mission, absorbs the efficiency of the water works to no purpose, it is the insurance company, not the water company,

that is the heavy pecuniary loser by reason of the error in construction.

It is safe to say that whenever in dealing with the water-works people, loose or questionable practices prevail, the practice is not radically different in dealing with the insurance people. It is equally safe to say that where the pecuniary loss of the water works on this account may be measured in dollars, that of the insurance people runs into thousands of dollars.

The value of the water which may, without detection, be abstracted from fire pipes is insignificant compared with the damage which may result from apparatus so used being in consequence found out of repair in time of need.

The interests of water and insurance companies may, at times, seem to conflict; but in my opinion, aside from the possible insignificant curtailment of the amount invested in insurance policies, by reason of the amounts paid to water companies for services in that line, the interests of insurance and water companies are ever identical.

Under public ownership in many cases in the past, the benefit accruing to the general public from the presence of private fire pipes has been regarded as sufficient to warrant the assumption by the general public of the expense, usually regarded as insignificant, of furnishing water for fire purposes only to such pipes.

It often happens that the water takers of a community are willing to have the major part of the cost of public fire protection included in the water tax, and not infrequently the same class of rate payers, or the general public more or less indirectly benefited, are willing to contribute largely to the expense of private fire protection.

No case of a private corporation receiving from the general public remuneration for such service rendered to other private corporations has come to my notice.

Experience in furnishing water to pipes supposed to be used for fire purposes only has resulted in a considerable modification of the perhaps formerly generally accepted idea as to the insignificant cost of such service.

It at times occurs that either through a desire to secure the greatest possible revenue from the water department, or through a desire to obtain the benefits incident to the public ownership of a water plant at the lowest possible cost to the individual water taker, or for some other reason, public sentiment, or some equally potent force,

demands that whenever a service is obtained of the water department by a private corporation or individual, an equivalent shall be rendered.

It is to the situation resulting from these latter conditions, to the case where there is neither tax levy nor generously disposed community of water takers to fall back upon, that our attention is now invited. "When necessary to assess the cost of private fire protection upon the parties directly benefited, how can the necessary assessment be most equably apportioned?"

I hope, gentlemen, I have succeeded in saying something you will object to, or that will induce you to say something on this subject. I will call on Mr. Walker.

Mr. Charles K. Walker. There is something about this insurance business I don't quite understand. For instance, some four or five years ago a document was presented to our water commissioners by some of our mill people stating that they had been told by the insurance folks that the water supply was inadequate for fire protection. The complaint came from two mills. Within two or three hundred feet of one of those mills there were five or six hydrants, and yet the insurance people had told them they had not sufficient fire protection; and the other mill was about six hundred feet from the hydrants, and they said they had been told by the insurance people that they were not sufficiently protected. In both of these cases they were supplied from the Amoskeag Reservoir and also from the city reservoirs. When the Amoskeag supply gave out they would come to us and say, "We want you to turn on the water from the city, because they are going to mend the other pipe," or something of that sort; and so we would go and turn the water on for them that they might not be without a water supply, and they have had that right along.

This was in 1896. The commissioners voted that if the mills would pay the six per cent. on the cost of the extensions required to go where they wanted the pipe put, they would put them in the ground the same as for individuals. Nobody has ever said a word about it since.

Now, the mills felt that they had supply enough, but it was the insurance folks who wanted a better supply. One of them came here last year and told us how to fix the gates. Well, there was nobody said a word in reply but friend Thomas from Lowell. The rest of us did not say anything, because we did not know but we

had done our duty right up to the handle. It seemed that Brother Thomas had too, but still he felt that he had got to tell these insurance men that he had. And so they come here year after year and tell us what we ought to do, and they come to the city and they say what size of pipe we have got to lay. It seems there is n't anybody who knows what size of pipe to lay except the insurance folks. There can't any living man tell me why, if a mill has this fire protection and sprinklers, they should not pay the city or the private corporation for them. I hope there are some of those fellows here to-day who will get up and try to tell me that.

They go on the ground that the mill is doing a good deal for the city, and that they are doing so much for the city that they ought to have the water for these sprinklers for nothing. But where are you going to stop if you work on that theory? You make the city pay for hydrants, and there are five or six of these hydrants with seventy-four pounds pressure within two hundred feet of one of these mills, and yet they said that they were afraid they had not water enough. Well, they did not want any more hydrants enough to pay for them. That is where the trouble is, and I am here to protest against giving these people everything for nothing.

If some of these water commissioners or some of the insurance men or some other fellow who can talk better than I can will get up and tell me why we should supply a mill with water unless we get pay for it, I should like to have him do so. My idea would be to have a meter on every place where they have these supplies, and then if they want to take the water let them take it and pay for it; and if they have a fire we will deduct what water they use in putting out the fire. But I do not think it is fair for us to fill their pipes and keep them full and not get any pay for it. Now, I am afraid I shall talk too much on this subject, — I talked about it all the way home the other day, — and I do not want to say any more on it; but I want to have somebody tell me why the city or private water works should furnish water for these people and not get any pay for it.

THE PRESIDENT. I understand that Mr. Pope is here representing the insurance interests, and we would like to hear from him.

MR. MACY S. POPE.* I would like to ask Mr. Walker what kind of a meter he would have, with 75 pounds pressure, and when they are drawing water for a fire.

* Inspector, Associated Factory Mutual Insurance Companies.

MR. WALKER. We have n't any meters; I wish we had.

MR. POPE. You have meters on some of your mills up there.

MR. WALKER. Not for fire, not for fire, young man; it is only for drinking water.

MR. POPE. Is n't there a meter at the Hosiery Company?

MR. WALKER. Not that I know of. I never saw one there, or heard of it, and nobody else.

MR. POPE. Four years ago, when I was there, they certainly had a meter on the by-pass.

MR. WALKER. Well, that might possibly be for the corporation. The Amoskeag Reservoir furnishes them with water, and that we have nothing to do with; but we help them out in case of fire.

MR. POPE. Are there meters on the Amoskeag water?

MR. WALKER. They have got them on the Amoskeag water, but we have n't any.

MR. POPE. The objection the insurance companies have to the use of meters on the fire supply is that as soon as you make any considerable draft through them the pressure is much reduced. I think that subject has been discussed here a good deal, and you probably all have the figures in your mind. So far as making a charge for the water is concerned, that probably remains to be settled between the mills and the water-works people. They can fight it out among themselves, and it does not interest the insurance people except indirectly. The use of meters, however, does interest the insurance people because it reduces the pressure to such a large extent that the fire service is very often seriously injured. If you will design a meter which will not reduce the pressure, then the insurance people may take a different position in regard to it.

I would like to ask to what extent water is stolen from the pipes, that is, where they are actually tapped into and water taken from other openings than the openings which are supposed to be used for fire protection only.

MR. WALKER. I wish I could tell you, but I can't, for we don't always catch them. I know, though, that there is some.

MR. J. WALDO SMITH.* This matter of the proper price to be paid for fire service in a mill always has been a bone of contention between the mill owners and the private water company. I speak from the private water company's standpoint. The mills always claim that they should not pay anything for having hydrants all over

* Engineer and Superintendent, Passaic Water Company, Paterson, N. J.

their yards and sprinkler systems all through the mills and that it is n't worth anything at all to them.

To answer the question asked by Mr. Pope in regard to how far they go in taking water without authority, I will say that in Paterson, Passaic, and Montclair, N. J., I don't believe there is one fire service from which the water has not been used contrary to the rules of the company. The only thing that will stop them is to put on meters and make them pay for all the water which goes through the meters. It has seemed to me that the best way to do was to charge a minimum rate, according to the size of the fire supply, and allow the mill to use up to that amount, and then if they use more, pay for it at the regular meter rate. The minimum rate would represent what the water company could afford to furnish that amount of water to the mill for.

It seems to me that some of the meters of the rotary class are so constructed that the head is not seriously cut down by a very large flow, and I would like to ask Mr. Pope, or any insurance man, what devices they have for preventing mills from, I won't say stealing water, but accidentally taking it? They always say it is an accident, and they are very sorry, but you may observe that they are never very severe on the man who causes the "accident."

Mr. F. N. Connet.* There are two incidents which lead me to think that water is sometimes taken from the fire service without being paid for. In our plant in Providence we make a great deal of hydraulic apparatus, and some time ago we had to test some of it at a much greater rate of flow than the ordinary water pipe connected with our manufactory would allow, and so we got permission to use the fire service for five minutes. After we had done so, we reported how much water we had used, and, as it happened, we reported to another man. The fact that we had reported, and so accurately, seemed to surprise him, and he was so pleased that he said he wouldn't charge us anything for the water. That is one incident.

Another case was in another city, within fifty miles of Boston, where there were at least half a dozen fire service connections, and the water company was assured that no water was being taken through them; but one day the superintendent of the water works thought he would test it, so he shut off one after another until only one remained open, and finally he shut that off and looked up at the mill; and in about two minutes there were about a hundred men

*Engineer, Builders Iron Foundry, Providence, R. I.

sticking their heads out of the windows to know what had happened, where the water was. I can't explain it, but perhaps some of the superintendents here can.

THE PRESIDENT. Will you not say something in regard to measuring devices which are supposed not to interfere too seriously with the pressure?

MR. CONNET. There are meters and meters. We all know that if we draw a curve representing the resistance that is offered to water by any meter, letting the vertical elements of the curve represent the resistance and the horizontal elements represent the velocity of the water through the meter, with some meters the curve will be almost horizontal until it gets up to about the capacity of the meter, and then the curve suddenly changes and goes almost vertically. Well, a water meter having a curve of resistance of that nature is certainly a very dangerous thing to place on any fire connection. But there are some other meters — at least one — where the curve is not of that nature; it is a gradually increasing curve, where the resistance varies almost exactly as the square of the flow. In other words, a meter having moving parts will have a curve of resistance of this undesirable nature that I mentioned first, whereas a meter not having any mechanical parts, and one through which the water flows without turning any corners, will have a curve which need not be objected to by the insurance people, and I understand they do not object to it. I am not mentioning any names.

MR. J. C. HAMMOND, JR.* This discussion has drifted somewhat from the line of the question as it was presented at the last meeting. We have a separate connection for fire direct from the main, and there is no water taken through it except to supply the sprinklers; there is a separate connection for all other purposes, on which is a meter. Now the question I raised in the first place was, what was a fair basis on which to make a charge for the use of water. At the last meeting Mr. French argued that no charge should be made, or only a nominal charge. That is all right if you have got a city to tax, but in the case of a private company, with bonds coming due in the future, we have got to look after our revenue, and it is no more than fair that we should have it. We laid a twenty-inch main to supply water for fire purposes to these various establishments, when a main half the size would answer for domestic purposes. They don't steal water in Connecticut, so this talk about the trouble in

*Treasurer, Rockville Water and Aqueduct Company, Rockville, Conn.

New Hampshire and Massachusetts of course does n't apply to us. But I will say this, that if anybody will stop to think of it for a minute it will be apparent that if there is any circulation of water in the sprinkler pipes, either in cold weather or in summer, the pipes will drip. If the water is not drawn it remains in the pipe at the temperature of the room; but if you draw any water out of it, and thus make it either warmer or colder, you will have a drip. We sometimes do find that, but it is always an accident.

Now the question is, How much shall the mills pay? The insurance people say we must n't do anything to drive the manufacturing concerns out of the place. That is all right. But if a man has got a cow down at the lower end of the town, he has got to pay for water for the cow and he has got to help pay for the hydrants to protect his house; while the corporation at the other end of the town can save largely in its insurance, reducing the rate from three per cent. down to one per cent. and then getting a dividend of anywhere from fifty to ninety per cent. back on that, and not pay anything; and the insurance people say that is as it should be. Now, I live in a hard cider country, and a fellow there made some cider just before the agricultural fair, and one of his neighbors suggested that they make a lot of money on cider. Said he, "You make up a barrel of cider and take it down to the fair ground, and I will furnish a faucet, and we will go halves." Now, if we will only furnish the water, the insurance people are willing to get the benefit of it. I think we had better go into the insurance business ourselves, or else have them provide some way for us to get a revenue from the water. It is a benefit to them to have us furnish it, the parties who have it acknowledge it is a benefit, and really the only question is, What is a fair basis on which to charge for it?

For instance, one establishment is a large cotton mill, where the risk is great; another is an envelope works, another a silk works; the raw materials are more or less combustible, more so in one case than another, and one has much larger interests to be protected than another. Now one plan would be, if we wanted to raise five hundred dollars or five thousand dollars, to take the amount of insurance which these several mills carry and then reckon a percentage on that to raise our revenue. Then a man who has a mill filled with valuable machinery, and who carries a large insurance, and who wants fire protection, can pay for it in proportion to his insurance. The fact that we are furnishing water for his sprinklers saves him a large

amount of insurance, and he is really willing to pay for it, — or he ought to be, — and the question is to determine what he shall fairly pay; and I asked the question in the first place thinking some of you gentlemen could suggest a fair way to assess it. At present each mill pays one hundred dollars. One mill will carry six or seven hundred thousand dollars of insurance, and another carries fifty thousand dollars, and yet each pays one hundred dollars. Some of them we have to furnish water to by pumping for the high service, and yet all pay the same price. It is n't fair, and they know it is n't fair; and I should like to find out, if I could, some plan on which each should pay its proper proportionate part, and I think they would be willing to do it.

Mr. Pope. I think the gentleman misunderstood the argument advanced by Mr. French at the last meeting with regard to charges by private corporations. I did not understand he thought that private corporations should not receive compensation for the water they furnish, but, reasoning in a logical way, he argued that it belonged to the municipality to pay for the fire service rather than for the mills to pay for it.

Mr. Hammond. Possibly so, sir; but I understood him to say that the corporation might make a merely nominal charge.

Mr. Pope. His argument was that the mills paid their general taxes the same as the householders pay their taxes.

Mr. Hammond. Does the public save anything on the insurance the mills have to pay?

Mr. Pope. No; but the public pays for the security just as the mills pay.

Mr. John C. Chase.* Did I understand the gentleman from Connecticut to say that the Connecticut water consumers are so honest that they never steal water?

Mr. Hammond. One minister did, — a Congregational minister, too.

Mr. Chase. He was n't a Baptist?

Mr. Hammond. No. We give them all they want. The gate was off in front of the parsonage, and the minister had his horse in the yard feeding, while he was running the lawn mower, and he placed the garden hose in such a way that it played right across the gateway and kept the horse from going into the street, making a new kind of water gate.

---

*Civil Engineer, Derry, N. H.

MR. CHASE. The only comment I was going to make was that if the Connecticut people were as honest as our friend would seem to imply, I thought it was unfortunate we could n't import some of them into some other States, — New Hampshire, for instance.

Now, as throwing a little light upon the subject under discussion, I would say that, as far as the corporation which I represent is concerned, if any consumer who wants a private hydrant will pay one hundred dollars a year, he gets a privilege of having a large connection, four- or six-inch, and maintaining fire hydrants and sprinkler service, and he is also permitted to have the use of one hundred dollars' worth of water per year, or more if he chooses to pay for it, measured through a meter. In fact, the fire protection is thrown in as a bonus to any one who pays one hundred dollars a year in water rates, if he chooses to maintain a system of fire protection himself. As we look upon it, the city pays us a round sum for fire protection, and it is immaterial to us whether they use the water in case of fire from their private pipes or from the city hydrants. The only trouble we have is in getting them to take the water only through meters, and I judge that that is a common trouble, from the remarks I have heard here. We have had no less than half a dozen cases of the grossest larceny in the stealing of water. In one of our largest cotton mills, after about two years it was discovered that they had deliberately made a cross-connection between the sprinkler system and the sanitary pipes in the mill, and had been taking about all the water that the mill required for use through it. That was cut off, and we thought they had learned a lesson. But there was a change of administration, and we soon had reason to believe that they were again stealing water. They have a condensing engine, and the supply is drawn by a pipe running out into the river. A meter was set on the service on a Saturday afternoon and the following Monday it was learned that the mill was shut down on account of the suction pipe of the condenser being out of order, and we have reason to believe that we had been furnishing the supply for a long time previously. Since the installation of the meter our income from this consumer has materially increased with a much less draft of water.

Now, this question narrows down, I think, to one of two things, — either devise a meter which will measure the water in a way which is satisfactory to the insurance people, if that be possible, or else educate people up to such a degree of morality that they will not steal water. Which is going to be the easier thing to do, — to work

from the mechanical or from the moral standpoint, — I will leave it to you gentlemen to decide. But I don't know why we should have any particular love for the insurance people. They don't contribute to our resources at all. All we can do with them is to make use of them as a sort of club to make our customers a little more honest, telling them that if they want the water for fire protection they must only use it in a legitimate way, and if they won't do that, then they must fight it out with the insurance people.

THE PRESIDENT. Mr. Holden is called for, and we would like to hear from him.

MR. HORACE G. HOLDEN.* I don't know as I have anything to say in regard to this matter. I represent a private water company, and we are naturally anxious to get all the income we can out of our water works; and if any of our customers want water for fire protection we are always willing to give it to them, provided they pay the cost of putting it in. If they are not customers of ours we charge them the same rates that we charge the city. We have a good supply of water, so we are not disposed to curtail on any one.

MR. CONNET. I would like to say one thing more. It seems to me that it is a mistake to assume that water companies have but one thing to sell, and that is water. They have two things to sell: one is water, and it is easy to measure that; the other is security against fire, and it seems to me that that should be paid for as willingly as any other form of security. It should be paid for as willingly as a premium on an insurance policy. Fire protection seems to me to be a sort of insurance in itself, and if a four-inch pipe is put in for fire protection it ought not to be a very hard matter to collect a minimum rate just about the same as the minimum rate for a four-inch pipe on any other branch of the service. It is insurance and a security which the consumer should be willing to pay for. Let us not forget, then, that the water-works companies have two things to sell.

MR. WALKER. I am afraid our friend from Connecticut will have to go back home without any information. He has asked how much would be fair, but I do not believe there is anybody who will get up here and tell him. He will have to take the members one side and ask them privately. I do not know what would be fair. It is according to where you are, whether you have to pump, and so on. But I should like to have him get all he can out of the insurance

*Superintendent, Pennichuck Water Works Company, Nashua, N. H.

companies. I want to be fair with everybody, including the insurance folks, and I would like to give our friend the information he wants, but you know you cannot always tell what to do, because there are so many different opinions about the matter. It seems to me that he has got one thing right, and that is that he should be paid a fair compensation. If he has a gravity system he can afford to do it cheaper than he could by pumping. We have to pump our water. But what looks fair to me is to use the Venturi meter, which these fellows come along and tell you about. They say it does not reduce the pressure a mite, — I do not know whether it does or not, — but it is so short that they say it does not make any difference in the pressure if the pipe is contracted. That is what they argue to me, and that is what their circular says. Now, if that is so, why not put on a Venturi meter and satisfy these insurance folks?

Dr. George W. Field. The condition which Mr. Walker has described as obtaining in Manchester reminds me of a story, which may have originated there, about a man who built a very handsome house high up on a hill, where people saw it and often remarked upon it. Two men were going by in a car one day, and one of them remarked on what a magnificent house it was. His companion replied, "Yes, it is a fine house, but rum built it." The owner of the house happened to be sitting in the car opposite the gentlemen, and he said, "Beg pardon gentlemen; I built that house. I sell rum and water. The rum just about pays for itself; that house was built on water."

Prof. William T. Sedgwick. It seems to me that this Association ought to have from time to time, and it does have from time to time, committees appointed to investigate and report upon just such questions as this. The rest of the country looks to the New England Water Works Association for points of progress. Now, here are a lot of opinions, complaints, practices, and so on. The whole question is a serious one, because the quantity of water which is supplied in a city is all the time demanded to be larger and larger, and it is getting to be a problem where the water supply of our cities is going to come from by and by. The quality of water has been improved, the private companies and the public authorities have done their best to improve it, and it is only fair that those who use the water should pay for it. That is admitted. But it is said that some basis ought to be determined upon for a proper compensation.

Now, this Association, it seems to me, could not do a better thing

than to appoint a committee, whose first duty would be to get at the facts on this subject. What are the facts? Is water stolen to any considerable extent, and if so, what action is needed, and how can that action be coördinated with the requirements of the insurance companies so as to meet the ends desired? It seems to me, as I said in the beginning, that the Association ought not merely to hear complaints and general suggestions, but should have a committee to look into the facts, and to make a report which would be valuable from this time on.

This interests me very much, because it is one of the questions affecting the consumption of water, and every sanitarian is interested nowadays in the problem which is so nearly before us, — What are we going to do to obtain the vast quantities of water that are required? We have got to do something. At present we are keeping up the quality and furnishing any quantity. That cannot go on forever. We have got to do something, somehow or other — perhaps put in a double system, perhaps put on more meters, or do something else, I do not know what. It seems to me that this Association ought not merely to discuss this matter, but should have a committee to investigate and report upon it. I do not make a motion that such a committee be appointed, because I do not know enough about the subject; but it has occurred to me as I have been sitting here that that is the proper thing to do, — have a committee which shall get at the facts, digest them, and make a report, and then you can discuss the report and adopt it if you see fit.

Mr. Byron I. Cook.* I think Professor Sedgwick's remarks are in the right direction. Almost every water-works superintendent who has a fire supply running into manufacturing establishments has at one time or another caught them using the water improperly; and I do not know as it can be helped. They say, "We got into trouble and we had to have some water, and we did not suppose you would miss a small amount." And I really think we shall not arrive at any satisfactory solution of this matter until the insurance people and the water people get together. We want help from them and they want help from us. It is a mutual thing. Acting upon Professor Sedgwick's recommendation, I will move that the President appoint a committee of five to consider this subject, and to report at a future meeting of the Association.

The motion was adopted, and later the President announced the

* Superintendent, Woonsocket Water Works.

committee as follows: Byron I. Cook, Edward V. French, J. C. Hammond, Jr., Charles K. Walker, and John C. Chase.

Regulations of Various Cities.

The following is the report of the meeting of the New Bedford Water Board at which the regulation of the use of private fire supplies was decided upon.

After the ordinary business of the meeting had been transacted, Superintendent Coggeshall read the following report: —

To the New Bedford Water Board:

Gentlemen, — At a meeting of this board held on September 6, 1900, the following vote was passed.

Voted, That the superintendent be instructed to lay before this board as soon as possible plans of the various mill supplies of this city, indicating thereon how the same can be completely metered in each case.

In compliance with this order, I would respectfully report as follows: —

Plans showing the piping system in each mill enclosure in this city are upon file in this office and are subject to your inspection.

It is customary in planning mill water supplies to divide said supply into two portions after it has entered the mill premises. Each portion has its distinct line of piping. One is intended to be used wholly for fire protection, the other to supply the daily manufacturing and domestic use. In the later built mills the fire supply is again divided into two distinct parts, — that for hydrant use and that for sprinkler supply. This enables either to be operated entirely independent of the other. Unless this be done, a break in the sprinkler system, such as would be occasioned by falling walls in case of a fire, would also cripple the hydrant supply.

Each mill has capacious steam fire pumps, which admits the pumping of salt water from the river into both sections of the fire pipe system. Check valves properly placed on the mill piping system make it possible for said pump to cause the water pressure to exceed the usual city water pressure. More effective fire streams are thereby obtained. The mill system is supposed to depend upon the city supply for only the earlier moments of a fire or until they can get their own pumps into full operation, when they will furnish the entire supply to their own system, leaving the city supply wholly for the use of the city fire department.

These systems vary from a simple one-pipe affair to the elaborate three separate pipes with connections to the pipes of adjoining cor-

porations, thus providing a way to obtain additional pump service in case of need.

It has been customary in all cities to allow the placing of unmetered pipes from the city mains into private property, with the understanding that its use is to be confined wholly to fire protection. The interests of water departments and insurance companies seem to conflict when it comes to the metering of the fire supplies. The insurance people claim that meters obstruct the flow and destroy the efficiency of the fire streams, especially should they get stuck. This is true of most of the types of meters. There are, however, exceptions to this statement, and meters can be supplied to which this objection will not apply.

The testimony of all cities agrees that private hydrants will be used more or less for purposes other than for fire protection, unless prevented by some form of restriction.

Here in this city no restriction is placed upon the use of the hydrants, other than the mill authorities know that they were allowed simply for fire protection, and not to be otherwise used. But there they stand, with the opening wrench close at hand. Any employee can open one and obtain a supply. He may give the matter very little thought other than he wants the supply for some purpose; and as the hydrant is conveniently placed, he goes and gets it without perhaps even informing the mill office. Water carts are filled, or a hydrant stream is used for a few moments to lay the dust; or perhaps a supply is wanted for some building purposes, or numerous other supplies may be needed. It is not denied that the hydrant water is used when the occasion presents itself. The most serious use has been the taking of large volumes for condensing purposes. This is done when a low run of tide in the river deprives the mills of their usual salt water supply. With one or two exceptions they have failed to provide an ample secondary supply to meet an emergency like this, so, as the matter now stands, they must at such times either use the hydrant water or stop portions of the mill. Such large volumes have been taken on several occasions for this purpose that for the time being the supply to a considerable portion of the elevated part of the city has been entirely cut off.

During the past year four of our corporations report that they have on several occasions used hydrant supplies for this purpose. In the absence of any rate for this purpose the manufacturing rate has been charged. The amounts charged upon the data supplied by these mills were $429, $259, $50, and $24. No reports of a similar use have been received from the remaining corporations.

Other cities have had this same question to contend with, and their experience may be of value to you.

Fall River has had an experience similar to that in this city. They allow an unmetered fire pipe, the supply from which is to be used for no other purpose except fire protection. The use of city water for condensing purposes is not allowed. Every time a hydrant is opened

except for fire purposes or they detect a supply being taken from the fire supply pipe they impose a fine of twenty-five dollars for each and every offense. They are of the opinion that the time is rapidly approaching when the metering of all manufacturing supplies will be an absolute necessity, as they lately have had several occasions when they have been obliged to impose this fine.

Providence has had similar trouble, and it has resulted in the establishment of an elaborate set of rules, a copy of which I submit with this report. The points which will be of most interest to you are as follows: —

They allow unmetered pipes for fire supplies, but every gate, valve, fire plug, or hydrant is sealed by a water department inspector.

All tests must be made in the presence of a water department inspector, who removes and replaces the seals, and a charge of three dollars for the first hour and one dollar for each additional hour is made for this service.

The seals may be broken only in case of a fire, of which written notice must be sent to the water department office within twenty-four hours after its occurrence.

No connection with any other supply is allowed. This prohibits the connecting of an auxiliary steam pump to operate another supply against a check valve, as is the case with the salt water pumps used in this city. Singularly enough, I am informed that this rule was adopted as the result of the failure of a check valve at a mill fire in this city some years ago, whereby considerable salt water was forced into the city mains.

There are several other provisions which are not of as much interest at this time. The penalty for the violation of the whole or part of any of these rules is from five dollars to fifty dollars for each offense, or be subject to having the supply shut off.

The experience of Pawtucket does not differ from the cases that have been cited. As a rule they have allowed an unmetered fire pipe, but they place seals upon all unmetered fire fixtures, the same as is done in Providence.

The water department inspector is present at every test, and removes and replaces the seals. For this service a charge of three dollars is made.

Some of the corporations insisted upon using the hydrants, and it has resulted in placing meters upon their supplies. After this was done no objection was raised against the use of the hydrants, as these mills were charged at fixed meter rates for all the water used. One of the largest corporations heretofore paying $3 500 for their yearly supply has taken the past year through a metered hydrant pipe water to the value of $5 700.

Large meters, with their necessary fittings and the placing of the same, are very expensive. To completely meter all the mill supplies would require the placing of a number of very large meters, and would involve an expense of nearly $30 000. A much smaller meter

has ample capacity to meet every daily requirement aside from fire and condensing supply.

If the hydrants are to be allowed to continue to supply water for condensing use or for any other foreign purpose, then that supply ought to be metered and a rate fixed for that use. Other than this, the adoption of a modification of the Providence rules, whereby all fire apparatus is to be sealed, would entail comparatively little expense as compared to the placing of the large meters.

Both Providence and Pawtucket report the results obtained by the sealing process to be very satisfactory.

R. C. P. COGGESHALL,
Superintendent.

The superintendent's report was adopted, and Mr. Pease introduced his order, as follows: —

Hereafter private fire supplies are to be allowed only upon the following conditions: —

I. All hydrants, fire plugs, valves, etc., necessary for private fire protection, which are supplied by an unmetered connection with the city mains, will be allowed under the condition that they remain sealed; and no water shall be used therefrom excepting in case of fire.

II. The seals shall be placed by a representative of the water department, and shall be removed only by a representative of the same department, excepting in case of fire. In such cases written notice shall be sent to the office of the water board within twenty-four hours after its occurrence.

III. No connection of pipes whereby the water from the fire pipes may be delivered into those furnishing the daily supply will be allowed. This applies to fire pumps where, by connecting its suction with the city water pipes of one system, delivery may be made into the pipes of another system.

IV. In case a fire supply is metered, the sealing of the different fixtures will not be considered necessary.

V. Tests of private fire supplies may be made by the owners thereof, or by insurance inspectors. It must be done in the presence of a water department inspector, whose sole duty will be to remove and replace the seals used on the fire apparatus and note the time required in making the test.

VI. Notice is to be given in advance at the office of the water department whenever a test is desired, when a date and hour will be agreed upon.

VII. All check valves upon the main supply pipes shall be inspected and overhauled by the superintendent at least once a year, and oftener if he considers it necessary.

VIII. All expense of inspection and repairs shall be charged to the party supplied.

IX. The penalty for violation of either of the above sections shall be the extreme penalty provided by the city ordinances for cases when openings or connections are made with the city water pipes without the authority of the water board.

Mr. Pease moved the adoption of his order.

"I don't want to be considered as opposing this order," said Mr. Hunt, "but it's an important matter, that I think we ought to take time to look the thing over and study into it. The report and the order are so extensive that it's a difficult matter to take it in at one reading."

Mr. Pease replied that the subject had been up for several months, and that the board knew as much about it then as they would ever know. The superintendent, he said, reported that hydrant water was being misused, and this was the most practical method of stopping the practice. It entailed no hardship on the manufacturers, but merely provided for seals so that they could not use water that they did n't pay for.

Mr. Hunt admitted that the matter ought to be adjusted. "I think," he said, "that the mayor has given this question of water rates and water supply considerable study, and we ought to wait for a full board. It would be better to take a reasonable time, so as to be acquainted with all the particulars and vote intelligently. I therefore offer an amendment that action on the matter be postponed until the next regular meeting, or a special meeting to be called by the mayor or the superintendent."

Mr. Pease declined to accept the amendment.

Mr. Hunt said he thought that the mill men ought to be given a chance to be heard.

To this Mr. Pease replied that he did not believe the mill men wanted to be heard. It was a question of stopping the stealing of water, and he asked Mr. Hunt whether he would want to wait and give a hearing to a man caught robbing a money drawer. Mr. Hunt thought it would depend.

At this point Mr. Taber seconded the motion to adopt the order, and on a vote Mr. Mason declared it carried.

The water rates of the city and county of San Francisco, Cal., adopted by the Board of Supervisors, June 2, 1897, provide : —

SECTION 9. *Fire Pipes.* — Meters shall be applied to all pipes used specially for fire protection, and monthly bills shall be charged for the same at regular meter rates, provided, however, that the monthly

bill shall not be less than fifty (50) cents for each one-half ($\frac{1}{2}$) inch diameter of pipe used.

Rules for the Use of Private Fire Supplies.

Providence Water Works.

Applications for private fire supplies must be accompanied by a full detailed plan, showing all connections contemplated with other fire supplies, tanks, and sewers which shall be approved by the city engineer before action will be taken thereon.

No changes, additions, or connections will be allowed except upon plans filed and approved in the same manner as with the original application for said supplies.

All work in connection with private fire supplies shall be done by a licensed plumber and under proper inspection, and all gates, valves, fire-plugs, and hydrants connected with such supply shall be sealed by the inspector when deemed necessary.

For the purpose of covering the expense of a proper inspection of the complicated systems of private fire connections now demanded, the following yearly rates will be charged, when Pawtuxet water is exclusively used for general purposes, viz.: —

For one (1) supply, $5.00.
For two (2) supplies, connected, but without auxiliary tank, $10.00.
Either one (1) or two (2) supplies connected to tank, $15.00.

When other water than that furnished by the City is used for general purposes, SPECIAL CONTRACTS OR LARGER ASSESSMENTS WILL BE MADE.

Private fire supplies and the fire apparatus connected with the same may be tested by the parties owning the same, or by insurance inspectors, under the following conditions: —

First. Notice to be given at the office of the commissioner of public works that such test is desired, when date and hour will be agreed upon for said test.

Second. All tests to be made in the presence of the inspector assigned by the commissioner, whose sole duty shall be to remove and replace the seals used on the fire apparatus and note the time required in making the test.

Third. The rates for testing are as follows: —

One hour or less, $3.00.

For all time in excess of one (1) hour, $1.00 for each hour or fraction thereof.

Fourth. Water shall not be used from any private fire supply, nor seals broken or removed, except in case of fire, written notice of

which is to be given at the office of the commissioner within twenty-four hours after its occurrence.

Fifth. Not more than two private fire connections from the city water mains will be allowed to any building or premises, except under exceptional circumstances, to be determined by the commissioner. The connections may be made from one or more streets if the building or premises fronts upon the same. No pipes, however, will be allowed to be laid across a street.

Not more than two private fire connections from the city water mains will be allowed to be connected together under any circumstances in any building or premises

When two private fire connections are connected together, a suitable check-valve must be placed upon each.

In conformity with the order of the Board of Health, no private fire system which is in any manner connected to the city water mains shall have any other supply of water. No valves of any description will be allowed as "shut-offs" to any other supply, as there must not be a possibility of any other supply of water to such pipes.

When a tank is connected to a private fire system which is connected with the city water mains, it shall be subject to the following conditions: The only water that will be allowed to be supplied to the tank will be the water furnished by the city. Said water shall be measured by a meter. The supply pipe leading to the tank shall be entirely independent of the fire system proper. It can be directly connected to the city water mains, or to a regular service pipe which supplies city water to the premises where the tank is located.

The outlet end of the supply pipe of a gravity tank shall be placed at least six inches above the maximum water line of the tank, and the supply pipe of a pressure tank shall be so arranged as to prevent the water in the tank from flowing back into the city water mains. Each tank shall have a suitable check-valve upon the pipe leading from it to the distribution pipes of the fire system, for the purpose of preventing water from flowing into the tank from the city water mains.

A gravity tank shall be roofed over and constructed to prevent rain, snow, dust, or any other objectionable matter from getting into it. Each tank shall have a manhole and permanent ladders arranged for convenient access to its interior, and shall have an outlet in its bottom, so that it can be emptied entirely independent of the pipes of the fire system. The interior of each tank shall be thoroughly scoured out at least once in twelve months.

All "drips" of fire systems, which are intended to empty into a sewer, shall first discharge into an open tank, the outlet pipe of which shall be deeply trapped and connected with the sewer in the usual manner.

Sixth. For each and every violation of the above, in whole or in part, the offending party, at the discretion of the commissioner, will

be subject to a fine of not less than $5.00 nor more than $50.00, or be subject to having the supply shut off.

Owners or agents of property protected by private fire supplies shall cause copies of Rules one to six to be kept posted conspicuously in their office, engine room, and upon each floor of any building where fire-plugs are located that can be used by any employee; and no plea of ignorance will be entertained by the commissioner.

PROVIDENCE, R. I., September 14, 1897.

PRELIMINARY REPORT OF THE COMMITTEE APPOINTED MARCH 3, 1901.

[*Presented by Byron I. Cook, Chairman, September 18, 1901.*]

Your committee appointed to report on the subject of "Apportionment of Charges for Private Fire Protection, and the Means of Controlling the Supply Thereto," have not had sufficient time to fully consider all the points relating to this question. The committee have had one meeting, at which there were present, Messrs. French, Chase, Hammond, and myself. It was suggested that Mr. H. A. Fiske, Manager Underwriters' Bureau of New England, be asked to confer with the committee, which he kindly consented to do. As Mr. Fiske is now a member of the Association, I will later move that he be made a member of the committee.

The questions submitted to your committee in the advance discussion, namely, —

First. Whether the opportunities for the taking of water without the knowledge of the water department afforded by the presence of private fire pipes are frequently taken advantage of or no;

Second. Whether the benefit to the general public from the presence of private fire pipes is sufficient to warrant the assumption by the general public of the expense incident to furnishing them with water or no;

Third. Whether the service rendered in supplying water for fire purposes only to private fire pipes merits compensation or no;

Fourth. Whether securing assurance of the use of private fire pipes for such purposes only is merely a matter of a few dollars, and may reasonably be required or no;

Fifth. Any other facts in regard to private fire pipes, the manner of their use, the value and cost of the protection afforded, upon

whom and how the cost of such protection should be assessed, etc., which the committee may see fit to present;
were considered.

As to the first, it was the opinion of the committee that this question admitted but one answer; that private fire pipes are frequently used for other purposes than fire protection.

The second and third questions have only been discussed in a general way. It has been suggested that a basis for charging for water for private fire supplies may be found in the number of fire streams that can be supplied at different pressures; this method has many advantages and is more equitable to all parties than a charge per hydrant or sprinkler head, but until further investigations your committee are not able to present any reliable figures.

The most important point in this whole question is, how can the water people be protected against the use of water from private fire pipes for other than fire purposes. Sealing of valves and hydrants, with the most rigid inspection, does not fully protect. This method is faulty as no means are provided to inform the water department of the quantity used.

I have no doubt that you will fully agree with me that cases are few where private fire pipes have knowingly been tapped for the purpose of drawing water. What the water superintendent wants is the amount taken and just compensation for the same, when "I wanted a little water so I just took it." This can only be settled by some form of measurement, and the water meter is looked to, to do the work. The meter for this purpose must be of low cost, and so constructed that it will not retard the flow of water. Pipes for fire protection will then have to be entirely independent of other supplies. Your committee is fortunate that a short time previous to their appointment, investigations were commenced by the inspection department of the Factory Mutual Fire Insurance Companies of a form of proportional meter. As these experiments are still in progress and as your committee can have the benefit of the results, it would seem best that a final report be not made until these investigations are completed.

It is the intention of your committee to submit, if possible, a final report based upon reliable data and one that will be acceptable to all parties interested, as the best way to adjust this question. The supplying of water for private fire pipes is one of the most vexatious matters in water-works management, and I have no doubt that you

will agree with me that if the New England Water Works Association, through its committee, can solve this problem agreeably to all, it will confer a lasting benefit upon the water fraternity.

I will say that since the meeting of the committee I have resigned from active management of a water-works plant, and as my business in the future will not enable me to give much time to this important matter, I wish to be relieved from service as Chairman of the committee. I am willing to give what time I can as a member of the committee. I move that President Crandall and Mr. H. A. Fiske, who has to-day been elected a member of the Association, be added to the committee.

Adopted.

PROCEEDINGS.

June Meeting and Excursion.

Somerville, Mass.
June 12, 1901.

Through the courtesy of his Honor Mayor Edward Glines, and by invitation of Water Commissioner Frank E. Merrill, Vice-President New England Water Works Association, the day was spent in Somerville as their guests.

The following members and guests were present: —

Members.

Francis E. Appleton, L. M. Bancroft, Fred Brooks, Joseph E. Beals, G. W. Batchelder, C. H. Baldwin, G. A. P. Bucknam, E. J. Chadbourne, George Cassell, R. C. P. Coggeshall, Byron I. Cook, W. E. Foss, F. F. Forbes, A. D. Fuller, F. B. French, W. J. Goldthwait, W. R. Groce, H. F. Gibbs, F. W. Gow, A. A. Gould, Frank E. Hall, John O. Hall, J. C. Hammond, Jr., J. H. Higgins, H. G. Holden, Willard Kent, C. F. Knowlton, A. E. Martin, W. E. Maybury, F. E. Merrill, Thomas Naylor, J. H. Perkins, Horatio N. Parker, C. E. Riley, W. W. Robertson, H. E. Royce, P. P. Sharples, E. M. Shedd, Charles W. Sherman, H. O. Smith, G. H. Snell, J. J. Sullivan, W. F. Sullivan, H. L. Thomas, R. J. Thomas, W. H. Thomas, D. N. Tower, G. W. Travis, W. W. Wade, C. K. Walker, G. E. Wilde, G. E. Winslow, E. T. Wiswall.

Associates.

Barr Pumping Engine Co., by W. H. Bodfish; Builders Iron Foundry, by F. N. Connet; Chapman Valve Co., by E. F. Hughes; Coffin Valve Co., by H. L. Weston; Garlock Packing Co., by H. A. Hart; Hersey Mfg. Co., by A. S. Glover; Henry F. Jenks; Lead Lined Iron Pipe Co., by T. E. Dwyer; National Meter Co., by J. G. Lufkin and C. H. Baldwin; Perrin, Seamans & Co., by J. C. Campbell; Rensselaer Mfg. Co., by Fred S. Bates; A. P. Smith Mfg. Co., by W. H. Van Winkle; Union Water Meter Co., by J. P. K. Otis; R. D. Wood & Co., by C. R. Wood.

Guests.

George E. Ames, Lowell; Fred A. Beals, Everett; Francis H. Boyer, Somerville; James S. Beal, Hingham; John H. Crandon, Chelsea; G. W. Cormack, Stoneham; C. N. Fairbanks, Boston; J. W. Goodell, Burlington, Vt.; H. A. Gorham, Boston; J. T. Inman, Attleboro; F. E. Jones, Somerville; F. A. Morrison, Boston; A. F. Nagle, Neponset; G. E. Pickering, Somerville; T. J. Perkins, Watertown; L. P. Stone, Natick; J. T. Stev-

ens, Braintree; F. P. Skinner, Rockville, Conn.; W. W. Trowbridge, Newton; E. P. Walters, Boston; L. K. Woods, Everett; W. P. Jones, Somerville *Journal;* E. L. Pease, Somerville *Citizen.*

Also the following officials of the city of Somerville: Mayor Edward Glines, Aldermen Watters, Wentworth, Gilman, Belcher, Vinal, Pike, Caldwell, Simonds, Lowell, Littlefield, Woodbury, Reynolds, Frye, Waugh, and Smith, Street Commissioner Pritchard, Building Commissioner Fuller, City Messenger Mann, Mayor's Secretary Warren.

BUSINESS MEETING.

CITY HALL, SOMERVILLE, MASS.
June 12, 1901.

Vice-President Walker in the chair.

Vice-President Merrill, Water Commissioner of Somerville, introduced Mayor Glines, who welcomed the Association to the city, in which he was seconded by President Vinal, of the Board of Aldermen. Vice-President Walker replied to these addresses.

Applications were received from the following: —

For Member.

J. G. Falcon, Evanston, Ill.; V. R. Hughes, Napoleon, Ohio; Charles Anthony, Jr., Buenos Ayres, Argentina; Francis H. Boyer, Somerville; J. F. Sprenkel, York, Pa.; F. H. Pitcher, Montreal, Canada; E. Wegmann, Katonah, N. Y.; C. A. Lowell, Winooski, Vt.; J. F. Gross, Jenkintown, Pa.

For Associate.

International Steam Pump Co., New York City.

On motion, the Secretary was directed to cast the ballot of the Association for the above applicants, which he did, and they were declared elected.

The business meeting then adjourned.

The itinerary for the day included visits to the following points of interest: —

Prospect Hill, the site of a proposed municipal park, where one of the most important forts of the American entrenchments was located during the siege of Boston, 1775–76; Central Fire Station, engine house, and fire alarm system; Central Hill Park and battery; the English High School; the Public Library; City Hall; the Central Club; the old Tufts House, the headquarters of General Lee in 1775–76; Broadway Park and Ten Hills Farm (Governor Winthrop's residence, 1631); Winter Hill; Water Department Building, where

lunch was served; Old Powder House; Tufts College; Mystic Reservoir, of the Metropolitan Water Works, where the party assembled and passed a unanimous vote of thanks to the Mayor and City Government of Somerville, and to Water Commissioner Merrill; the old Timothy Tufts House on Elm Street; Spring Hill; and the works of the North Packing and Provision Company. At this point the party was received by Mr. Charles A. Cushman, General Manager of the Company, and shown over the works, and was further entertained by a luncheon, at the conclusion of which an enthusiastic vote of thanks to the Company and to Mr. Cushman was passed.

PROCEEDINGS OF THE TWENTIETH ANNUAL CONVENTION.

September 18, 19, and 20, 1901.

PORTLAND, ME.,
September 18, 19, and 20, 1901.

The twentieth annual convention of the Association was held in Portland, Me., on Wednesday, Thursday, and Friday, September 18, 19, and 20, 1901. The headquarters of the Association were at the New Falmouth Hotel. The opening session of the convention was held in the Council Chamber of the Portland City Hall, where the members were welcomed by the mayor of the city; the subsequent meetings were in the convention hall at the hotel. Because of the funeral of President McKinley, which occurred on Thursday, the 19th, the regular program for the sessions on that day was omitted, and no business was transacted.

The following members and guests were registered: —

MEMBERS.

Charles H. Baldwin, Lewis M. Bancroft, Joseph E. Beals, Forrest E. Bisbee, James W. Blackmer, George Bowers, James Burnie, A. H. Burse, George Cassell, Byron I. Cook, F. H. Crandall, George K. Crandall, J. W. Crawford, Allan W. Cuddeback, Eben R. Dyer, August Fels, B. R. Felton, Murray Forbes, Andrew D. Fuller, D. H. Gilderson, T. C. Gleason, Albert S. Glover, Frederick W. Gow, E. H. Gowing, James W. Graham, Frank E.

Hall, George W. Harrington, V. C. Hastings, W. C. Hawley, T. G. Hazard, Jr., Willard Kent, Charles F. Knowlton, Harry A. Lord, Cyrus M. Lunt, A. E. Martin, Frank E. Merrill, William Murdoch, Frank L. Northrop, W. Paulison, Edward L. Peene, F. H. Pitcher, J. B. Putnam, Walter H. Sears, Edward M. Shedd, Charles W. Sherman, M. A. Sinclair, H. T. Sparks, Robert J. Thomas, William H. Thomas, George P. Wescott, John C. Whitney, W. P. Whittemore, C.-E. A. Winslow, George E. Winslow, E. T. Wiswall. — 55.

Honorary Member.

F. W. Shepperd. — 1.

Associates.

Ashton Valve Co., by C. W. Houghton; Builders Iron Foundry, by F. N. Connet; Coffin Valve Co., by H. L. Weston; Garlock Packing Co., by Horace A. Hart; International Steam Pump Co., by George J. Foran; Hersey Mfg. Co., by Albert S. Glover and Francis C. Hersey, Jr.; Henry F. Jenks; Kennedy Valve Mfg. Co., by M. J. Brosman; Lead Lined Iron Pipe Co., by Thomas E. Dwyer; H. Mueller Mfg. Co., by F. B. Mueller; National Meter Co., by Charles H. Baldwin and J. G. Lufkin; Neptune Meter Co., by H. H. Kinsey; Rensselaer Mfg. Co., by Fred S. Bates; A. P. Smith Mfg. Co., by W. H. Van Winkle; Sumner & Goodwin Co., by Frank D. Sumner and Frank E. Hall; Sweet & Doyle, by H. L. DeWolfe; Thomson Meter Co., by S. D. Higley; Union Water Meter Co., by J. P. K. Otis and Frank L. Northrop; United States Cast Iron Pipe and Foundry Co., by E. T. Stuart; Walworth Mfg. Co., by George E. Pickering; R. D. Wood & Co., by Charles R. Wood; The George Woodman Co., by Wm. B. Durfee. — 23 associates, by 26 representatives.

Guests.

Mrs. George Bowers, Mrs. J. W. Crawford, Miss Ellen M. Weaver, Lowell, Mass.; Mrs. Wm. H. Thomas, Miss Helen A. Thomas, Hingham, Mass.; Mrs. F. N. Connet, Providence, R. I.; Mrs. Edward L. Peene, Mr. and Mrs. Michael Walsh, Yonkers, N. Y.; Mr. and Mrs. Wm. W. Locke, South Framingham, Mass.; E. L. Arundle, M. F. Collins, Lawrence, Mass.; Mrs. George E. Winslow, Waltham, Mass.; Mrs. Willard Kent, Raymond Kent, Narragansett Pier, R. I.; Miss Jessie A. Murdoch, St. John, N. B.; Mrs. George K. Crandall, New London, Conn.; Miss Hattie L. Northrop, M. L. Northrop, Saco, Me.; Miss Cora B. Pike, Boston, Mass.; Charles S. Warde, Staten Island, N. Y.; Hon. Frederic E. Boothby, C. W. Fenn, N. E. B. Merrill, Portland, Me.; Mrs. George J. Foran, Boston, Mass.; Mrs. C. F. Knowlton, Quincy, Mass.; Mr. and Mrs. James P. Bacon, Cambridge, Mass.; Miss Mary K. Gleason, Ware, Mass.; Mrs. W. H. Van Winkle, Newark, N. J.; Mr. and Mrs. Kendall Pollard, Swampscott, Mass.; Mr. George F. West, Portland, Me.; M. O. Leighton, Montclair, N. J.; W. N. Goddard, Henry M. Clark, Boston, Mass.; W. F. Wirsing, Greensburg, Pa.; M. N. Baker, Associate Editor *Engineering News*, New York City; George H. Part-

ridge, *Engineering Record*, New York City; John A. Hennesey, Erie, Pa.; W. W. Trowbridge, Miss J. M. Ham, West Newton, Mass. — 42.

SUMMARY OF ATTENDANCE.

Members	55
Honorary Member	1
Representatives of Associates	26
Guests	42
	124
Names counted twice	4
Total Attendance	120

WEDNESDAY, SEPTEMBER 18.

The Association met in the Council Chamber of the Portland City Hall at 11 A.M., President Crandall in the chair. His Honor Frederick E. Boothby, Mayor of Portland, was presented by the President and spoke as follows: —

Address of Welcome by Mayor Boothby.

Ladies and Gentlemen of the New England Water Works Association: We read and are told of the resources of the South, of the grandeur and the manufactures of the Middle States, of the population and the granaries of the West and Northwest, and of the possibilities of the Pacific Coast, but of late years, especially at this season, attention is more and more being diverted to the old Northeast, and I welcome you to-day to its fairest gem, — Portland-by-the-Sea.

It is fitting that you should come to the State of Maine for your meeting, the State around and within which there is so much water; for, taking the shore line, for instance, while the length of the same in a nearly direct course is less than two hundred and fifty miles, yet with the sinuosities of the shore, of boundary river courses, etc., there are about twenty-five hundred miles of coast. Again, within the borders of the State there are, according to recognized authorities, 1 620 lakes with an aggregate area of 2 300 square miles, which, connected as they are with the river systems, afford storage for the vast quantities of water needed by the 5 151 rivers and streams in the State.

While Maine cannot really be considered a mountainous State, it is distinctively a hilly one, and its valleys thus afford the necessary reservoirs for its vast number of lakes. Many of these lakes are

situated within easy distance of large cities and towns, and are thus convenient for the operation of water works, in which you are so deeply interested. Very few of our cities and towns are obliged to obtain their water supply from rivers, liable to pollution by manufacturing establishments, etc., but most of them are able to obtain from said lakes the purest of water; and right here in Portland we are willing to challenge the world to produce better water than our Sebago; and I am exceedingly glad that on Friday next you are to view Sebago Lake for yourselves, and trust it will be found satisfactory.

As you know, Maine has become a great vacation State, and the city of Portland is during the season filled with visitors, and to my mind it is not only the magnificent scenery of shore, mountain, river, and lake which is to be had in Maine, but its popularity is due to the quality of its drinking-water as well. How much different, then, are we from our Western brethren. At our hotels you can always tell the strangers by their orders for Apollinaris water, they not knowing of the purity of Sebago though of late years I will acknowledge they order Poland as frequently as Apollinaris.

It is somewhat a matter of regret that your meeting here should be held at a date after the amusement season had closed, though all of our resorts are still open, and I trust it is your intention to visit the same and to also view our beautiful city, and shall hope to later hear that your verdict is that we are all right.

Yesterday I had the report of the Board of Registration handed me, and find that our number of polls is 14 307; and while by the last census our population is 50 145, — and you know we never think such a count correct, — yet with the adjoining cities of South Portland and Westbrook, and the towns of Cape Elizabeth, Falmouth, Cumberland, and Yarmouth, the population of "greater Portland," so to speak, exceeds 75 000, or more than one tenth of the entire State.

Our valuation as rendered by the assessors is $46 000 000, and as the full valuation is hardly ever turned in, we have certainly over $50 000 000, or an average of $1 000 for each inhabitant, a fact which few if any cities can equal.

I have examined your program and note the elaborate subjects up for discussion. There is another which is of deep interest to me, although not new. In my frequent trips over the country, I often find absolutely no trace of streams that I used to know, and some from which I used to catch quite large fish; and is this not due to the

demolition of our forests? and is it not a fit subject for your honorable body to consider? Being, as I am, unacquainted with your proceedings, it is possible that you have already treated this subject. Scientists tell us that the shade afforded by trees prevents the sun from parching away the water contained in the ground, and here in Maine our forests, for the greater part, being evergreen, shade the ground at all seasons. We are also told that forests check the movement of the atmosphere, and thus prevent the removal of moisture from their area; and again, that forests roughen and break up the ground through which their roots force passage, so that the water penetrates it. But I do not propose to keep you longer with words on a subject in regard to which you are better informed than I, but cannot help mentioning one which appeals so strongly to me.

Again, then, bidding you a hearty welcome to our city, which is but the gateway to many points of interest beyond, I will close by hoping for a better acquaintance, which shall result in a more frequent interchange of visits, so that a pilgrimage to Portland will be an annual event in your lives. [Applause.]

THE PRESIDENT. Mr. Mayor, in behalf of the New England Water Works Association I thank you for your words of welcome. I am reminded, as I stand before you, of an incident which occurred, I believe, in Auburn, in this State, when the president of a Dorcas Society, responding to words of welcome by an eloquent pastor, told the gentlemen that his kindness was only equaled by his extreme good looks. I assure you, Mr. Mayor, that your kindness is appreciated by all the members of the Association, and —

THE MAYOR. How about the good looks? [Laughter.]

THE PRESIDENT. I was going to add that I know that the ladies have all been particularly impressed by those. [Laughter and applause.] As you are perhaps aware, in the constitution of the New England Water Works Association provision is made, lest becoming fixed like a plant in one peculiar spot we should share the common fate of plant life, for the holding of our annual conventions in different localities. With your fair city, its historic associations, its beauty of location and the energy, enterprise, and public spirit of its citizens to inspire us, I feel sure that the success of our present convention is assured. Again thanking you, Mr. Mayor, for your cordial reception, I extend to you, and to any of your fellow-citizens who may be interested in water-works matters, an

equally cordial invitation to attend our meetings and to participate in whatever of profit and pleasure may result from the sessions of our twentieth annual convention. [Applause.]

We will now proceed with the business of the hour.

Mr. George P. Wescott.* I move you, Mr. President, that at the close of our session this evening the convention adjourn, and that we do no business on Thursday, but observe the day in recognition of the funeral at Canton, Ohio, of the late President of the United States, William McKinley.

Mr. August Fels. I think it very appropriate that we, as members of the New England Water Works Association, should thus publicly express our deep sense of the nation's loss, and I therefore second the motion.

The motion was adopted. The Mayor announced that services would be held on Thursday morning in various churches, which he named, and in the afternoon at City Hall, to which he especially invited the members of the Association.

New Members Elected.

The Secretary read the following names of applicants for membership: —

Resident.

Charles W. Fenn, Portland, Me., Manager Mechanics Falls Water Works, Manager and Treasurer North Berwick Water Works, Engineer of Caribou Water and Electric Light Co.

Frank A. McInnes, Dorchester, Mass., Engineering Department, Boston Water Works.

Edwin F. Dwelley, Lynn, Mass., Civil Engineer.

Henry A. Fiske, Newton Center, Mass., Manager, The Underwriters Bureau of New England.

L. R. Woods, Everett, Mass., Superintendent Everett Water Works.

Charles A. Mixer, Rumford Falls, Me., Engineer in charge of design construction and maintenance of works.

Michael F. Collins, Lawrence, Mass., Superintendent of Water Works.

Jerome W. Goodell, Burlington, Vt., Water Commissioner.

Non-Resident.

Joseph C. Beardsley, Cleveland, Ohio, Second Assistant Engineer, Cleveland Water Works.

---

*Treasurer, Portland Water Co.

M. N. Baker, Montclair, N. J., Associate Editor *Engineering News*, Consulting Engineer and member Board of Health, Montclair, N. J.

John Goodell, New York, Managing Editor of the *Engineering Record*.

Associate.

J. B. Campbell Brass Works, Erie, Pa.

On motion of Mr. Robert J. Thomas, the Secretary was instructed to cast the ballot of the Association for the applicants, which he did, and they were declared by the President to have been elected members of the Association.

Committee to Nominate Officers.

Mr. C. W. Sherman. In compliance with the provision of the constitution requiring that a committee to nominate candidates for officers for the ensuing year shall be appointed at this convention, in such manner as the convention shall decide, I move that the President appoint a committee of five to bring in a list of nominations of officers for the year 1902.

The motion was adopted and the President appointed as the committee: Messrs. Dexter Brackett, Boston; George A. Stacy, Marlborough; Charles H. Baldwin, Boston; F. F. Forbes, Brookline; J. C. Whitney, Newton.

On motion of Mr. Fels the convention adjourned to 2 P.M.

Afternoon Session.

The President read the following letter from the Portland Company, inviting the members of the Association to visit its works.

Portland, Me., September 18, 1901.

Mr. F. H. Crandall, President New England Water Works Association, Falmouth Hotel, City.

Dear Sir, — We wish to extend to the members of your Association a cordial welcome to Portland, and to state that we should be glad at any time to have any of the members visit our works, and will take pleasure in showing them through.

Our shops include iron and brass foundries, machine shops, boiler, tank, and blacksmith shops, and elevator shop.

We are now building four (4) standpipes for water works, and also some very large pipe for a pumping plant.

While we are not specialists in any line of manufacture, our plant enables us to build a great variety of work in iron and wood.

With best wishes for a successful and enjoyable meeting for your Association, we remain,

Yours very truly,

PORTLAND COMPANY.

Mr. Charles-Edward Amory Winslow read a paper entitled "Bacteriological Analysis of Water and Its Interpretation. — Demonstration of Cultures." The subject was discussed by Mr. George E. Winslow, of Waltham; Mr. W. C. Hawley, of Atlantic City, N. J., and Mr. M. F. Collins, of Lawrence.

UNIFORM STATISTICS.

The next matter on the program was the report of the committee on "Uniform Statistics."

MR. JOHN C. WHITNEY, of Newton, said that the report was in the hands of the chairman, but he had been detained and would not be present until the following day. He suggested that Mr. Sherman, who had been present at the meeting of the committee when the report was prepared, probably had it all in his head and could give it to the Association.

MR. C. W. SHERMAN. I am not authorized, Mr. President, to say anything for the committee. I met with two members of the committee by request last Saturday afternoon, and we discussed possible desirable modifications or simplifications of the present existing summary of statistics, and a possible extension of it to cover filtration or purification works. I have a minute of what we discussed at that time, but I am not authorized to say anything for the committee; so unless the chairman appears with the report before we adjourn we shall have to wait till a later meeting before we hear it.

THE PRESIDENT. Could you not give us some information as to how our own statistics are being accepted by the members, whether they seem to be satisfactory, and whether they are being adopted by an increased number of works, and generally with regard to this matter?

MR. SHERMAN. I shall be very glad, if the members care to hear me, to say a little on the subject of statistics in general, without having it come under the head of the report of this committee. As

some of you know, and more of you will when you get the next JOURNAL, I have been spending part of my spare time this summer in compiling statistics from the water works reports for publication in the next JOURNAL. I made a special attempt to secure reports from all cities and towns containing summaries of statistics in the form adopted by this Association, and I believe I have all such reports which had been published up to the time of going to press with that part of the JOURNAL. I also succeeded in securing manuscript reports on blanks furnished by the Association from eight other municipalities, and found statistics in reasonably accessible form, giving a good deal of the data called for, in twenty other reports, which were accessible to a sufficient extent to pay for compiling the figures. I have brought those figures together in a tabulation which will appear in the September JOURNAL. There are sixty-one municipalities represented in this tabulation, the figures for twenty of which were compiled, as I say, from reports not using our summary or statistics. I have reason to believe that most, if not all the places from which I received manuscript statistics will adopt the summary in their next published reports; and one other city, Reading, Pa., whose printed report has only been received within a week, has adopted the summary this year.

It is proposed by the Executive Committee to print, as we have done this year, although too late for most municipal reports, blank forms of the summary, giving the various items and leaving the figures blank, so that any superintendent who desires to use the summary in his report will have simply to fill in the figures, cross out the headings not applicable to his particular works, and send the sheets thus filled out to the printer as a part of his annual report, and thus almost no labor will be involved in its preparation.

I might also say that Mr. Beals, the chairman of this committee, tells me that he has received a large number of letters from committees of allied associations, having to do with uniform statistics, and from individuals, asking about the progress of water-works statistics, and requesting suggestions, but not one of them offering a suggestion. And I may mention the fact that several water works in what we used to call the Western States, the Western Central States, situated at considerable distances from New England, and in some cases not represented in our membership, have summarized their statistics practically in the form recommended by this Association; and in all probability the slight variations from that form have

been due to the fact that no authentic statement of just what the Association recommends has been obtainable except in an early and comparatively rare volume of our proceedings, and the headings were probably obtained from other reports purporting to use our statistics, but in which, for various reasons, perhaps, they had been slightly varied from time to time, eventually resulting in quite a modification.

Mr. George E. Winslow, of Waltham, Mass., related his "Experiences in Reducing Water Ram Produced by Direct-acting Pumping Engines."

The President announced that an invitation had been received from a member of the Association, Mr. Wescott, to attend a banquet at seven o'clock on Thursday evening, in the dining-room of the New Falmouth Hotel.

Mr. Sherman. As we probably will not have a business session to-morrow or on Friday, it seems to me that this is the proper time to tender to Mr. Wescott the thanks of the Association for his kind invitation; and I therefore move a vote of thanks at this time in order that it may appear in the records of the business meeting.

Adopted.

Evening Session.

The Secretary read the application of Charles S. Warde, Staten Island, N. J., Cashier of the Staten Island Water Company, for non-resident membership. On motion of Mr. Cook, the Secretary was directed to cast the ballot of the Association in favor of Mr. Warde, who was declared elected.

Exhibit of Water-Works Appliances.

Mr. Henry F. Jenks, who had charge of the exhibit of water-works appliances, presented the following report: —

Report on Exhibits.

Meters.

National Meter Co., New York. Represented by J. G. Lufkin and C. H. Baldwin.

Hersey Manufacturing Co., Boston. Represented by F. C. Hersey, Jr., and A. S. Glover.

Union Water Meter Co., Worcester. Represented by J. P. K. Otis and Frank L. Northrop.

Neptune Meter Co., New York. Represented by H. H. Kinsey.

Thomson Meter Co., New York. Represented by S. D. Higley.

Tools and Supplies.

A. P. SMITH MANUFACTURING CO., Newark, N. J. Represented by W. H. Van Winkle.

SUMNER & GOODWIN CO., Boston, and H. MUELLER MFG. CO., Decatur, Ill. Represented by F. D. Sumner, F. E. Hall, and F. B. Mueller.

J. B. CAMPBELL BRASS WORKS, Erie, Pa. Represented by John A. Hennesey.

Valves and Hydrants.

COFFIN VALVE CO., Boston. Represented by H. L. Weston.

RENSSELAER MFG. CO., Troy, N. Y. Represented by Fred S. Bates.

Miscellaneous.

LEAD LINED IRON PIPE CO., Wakefield, Mass. Represented by T. E. Dwyer.

GARLOCK PACKING CO., Boston. Represented by H. A. Hart.

HENRY F. JENKS, Drinking Fountains and Self-closing Faucets. Represented by Mr. Jenks.

F. W. SHEPPERD, New York. Special New England Water Works Edition, "Fire and Water."

Mr. William W. Locke, Sanitary Inspector, Metropolitan Water Works, South Framingham, Mass., read a paper entitled, "The Work of Sanitary Inspection on the Metropolitan Water Works." The subject was discussed by Mr. George E. Winslow, of Waltham, Mass.; Mr. Charles W. Sherman, of Boston; Mr. M. O. Leighton, of Montclair, N. J.; Mr. A. D. Fuller, of Wakefield.

Mr. Charles W. Sherman, in the absence of the members of the Committee on Standard Specifications for Cast-iron Pipe, read the report which had been handed him by Mr. Brackett, of the committee. The subject was discussed by Mr. W. C. Hawley, of Atlantic City, N. J.; Mr. J. C. Whitney, of Newton, Mass., and Mr. Byron I. Cook, of Woonsocket, R. I.

APPORTIONMENT OF CHARGES FOR PRIVATE FIRE PROTECTION AND THE MEANS OF CONTROLLING THE SUPPLY THERETO.

Mr. Byron I. Cook, of Woonsocket, R. I., presented a partial report of the committee on "Apportionment of Charges for Private Fire Protection, and the Means of Controlling the Supply Thereto." Afterwards, on motion of Mr. Cook, the meeting voted to add to the committee, the President (Mr. F. H. Crandall, of Burlington, Vt.) and Mr. Henry A. Fiske, of Boston.

On motion of Mr. Whitney a vote of thanks was extended to Mr.

George J. Foran, for his "work in solving the problem of who is who at this convention" by printing a numbered list of those attending.

Adjourned.

FRIDAY, SEPTEMBER 20.

There was no meeting of the Association, but the party went to Sebago Lake, and by steamer up the lake and the Songo River to the Bay of Naples Inn, where lunch was served; the return to Portland was made over the same route in the afternoon.

OBITUARY NOTES.

JOHN H. DECKER, who joined this Association on June 18, 1885, died at his home in Brooklyn, N. Y., on May 8, 1901.

He was born in Allegheny City, Pa., October 10, 1845. He received his education at the Pittsburg High School and the Western University at Pittsburg, but before graduating he enlisted in the One Hundred and Second Pennsylvania Volunteers and served from 1861 to 1863, when he was discharged for disability incurred in the battle of Fredericksburg.

Mr. Decker was well known in the West as a constructor of gas and water plants, and had been engineer and superintendent of the water works at Sioux City, Ia.; Hannibal, Mo.; Salina and Winfield, Kan. He was afterwards with the water-works department of the firm of Henry R. Worthington, and later became assistant water purveyor of the city of Brooklyn, the office being changed to assistant engineer in charge of distribution upon the incorporation of Greater New York. He held this position at the time of his death.

He was one of the founders of the American Water Works Association, and had been its president and secretary, serving in the latter position for nine years.

JAMES MONROE BATTLES, Superintendent of St. Mary's House for Sailors, East Boston, died at the House on June 8, 1901, after a protracted illness. Mr. Battles was born in New Market, N. H., March 2, 1830; son of Benjamin and Charlotte (Smith) Battles. During his early life, he was connected with the Middlesex Cotton Mills in Lowell, and, after many years of faithful service there, he connected himself with the carpet factory in Roxbury and the Merchant's Woollen Mills at Dedham. He was clerk of the Lowell Water Board for eight years, 1880–88. In 1888 he removed to East Boston, to take up missionary work among the sailors, and through his influence and untiring energy in connection with the Episcopal City Mission, he established that important branch of the mission known as St. Mary's House for Sailors, on Marginal Street, East

Boston, and of St. Mary's Church for Sailors adjoining the House. It is safe to say that since the death of Father Taylor there has been no laborer among the sailors in the port of Boston whose death will be more deeply deplored.

Mr. Battles was a life member of the Historic Genealogical Society of Boston, and was prominently connected with church work in the diocese of Massachusetts. He was married in 1866 to Mary Caroline Eaton. He became a member of the New England Water Works Association on June 21, 1882.

ARNOLD H. SALISBURY, Superintendent of the Lawrence, Mass., Water Works, died very suddenly of heart failure at Greenland, N. H., on July 5, 1901.

Arnold Hunt Salisbury was born in Providence, R. I., in 1833. He received his education in Providence and remained there until he was twenty-one years of age, when he went to Augusta, Ga. He lived in Augusta for a number of years, being engaged in the sash and blind business. He left Augusta to accept a position as overseer in the spooling department of the old Washington Mills in Lawrence, his brother, W. H. Salisbury, being agent at that time. Later he became master mechanic in the same mills. In 1875 Mr. Salisbury became connected with the Lawrence Water Works as foreman. He served in this position until May 26, 1887, when he was made superintendent, which position he held at the time of his death.

In addition to the prominent position which Mr. Salisbury held in the city by reason of his official duties, he was also prominent in business and social circles. He was a member of the firm of C. N. Perkins & Co., manufacturers of fire department supplies. He was elected a member of the New England Water Works Association on January 11, 1888.

Mr. Salisbury leaves a widow, one son, and two daughters.

WILLIAM H. LAING, who joined this Association on June 13, 1889, died at his home in Racine, Wis., on August 5, 1901.

Mr. Laing was born September 18, 1842, at Quincy, Mass. He served during the Civil War in the Twelfth Illinois Cavalry. He was afterwards in the railway mail service, and later became superintendent of mails at Racine. In 1887 he became superintendent of the Racine Water Company, and soon after he was made secretary; and held both positions until his death.

SAMUEL G. STODDARD, Jr., Superintendent and Engineer of the Bridgeport Hydraulic Co., died at his home in Bridgeport, Conn., on August 21, 1901. He was thirty-four years of age, and left a wife and one child.

He was born in Westville, Conn., and was educated in the Bridgeport schools. After leaving school he entered the employment of Schofield & Starr, engineers, and remained with them until he was made engineer of the Bridgeport Hydraulic Co., and later became superintendent as well. He had entire charge of the construction of the Easton reservoirs, and has been most actively engaged in the building of the Beaver Brook Reservoir in Stratford, and the Uncowa distributing reservoirs in Fairfield, and the introduction of the company's water system to Fairfield and Southport. He was but twenty-four years old when he was appointed engineer of the water company, and only thirty when he became its superintendent.

Mr. Stoddard was elected a member of the New England Water Works Association on June 9, 1892.

INDEX TO ADVERTISEMENTS.

	PAGE
ARTESIAN AND DRIVEN WELLS.	
B. F. Smith & Bro.	xx
BOILERS AND TANKS.	
Scannell & Wholey	xi
BRASS GOODS.	
J. B. Campbell Brass Works	x
The Peck Brothers & Co.	viii
The A. P. Smith M'f'g Co.	viii
Sumner & Goodwin Co.	facing 2d cover
Walworth M'f'g Co.	ix
CAST IRON PIPE AND SPECIALS.	
Builders Iron Foundry	xvii
Davis & Farnum M'f'g Co.	x
Donaldson Iron Co.	xvi
M. J. Drummond & Co.	xvii
U. S. Cast Iron Pipe and Foundry Co.	xv
Warren Foundry and Machine Co.	xvi
R. D. Wood & Co.	xiv
CEMENT.	
Lawrence Cement Co.	xxiv
FILTERS.	
New York Continental Jewell Filtration Co.	xi
FURNACES, ETC.	
Perrin, Seamans & Co.	xxiv
The A. P. Smith M'f'g Co.	viii
GAS ENGINES.	
National Meter Co.	iii
GATES, VALVES, AND HYDRANTS.	
Ashton Valve Co.	xi
Coffin Valve Co.	xix
Eddy Valve Co.	xviii
Kennedy Valve M'f'g Co.	xviii
Ludlow Valve M'f'g Co.	xix
Mason Regulator Co.	x
Rensselaer M'f'g Co.	xx
Walworth M'f'g Co.	ix
R. D. Wood & Co.	xiv
LEAD AND PIPE.	
Chadwick-Boston Lead Co.	xiii
Lead Lined Iron Pipe Co.	xii
National Lead Co.	x
Sumner & Goodwin Co.	facing 2d cover
Walworth M'f'g Co.	ix
METERS.	
Hersey M'f'g Co.	iv
National Meter Co.	ii
Neptune Meter Co.	vii
Thomson Meter Co.	vi
Union Water Meter Co.	v
Venturi Meter	xxviii
PACKING.	
Boston Engineers' Supply Co.	xxv
A. W. Chesterton & Co.	xxv
Eagle Oil and Supply Co.	xxiii
Garlock Packing Co.	xxviii
The Gould Packing Co.	xxvii
PAINTS.	
National Paint and Varnish Co.	xxvii
PUMPS AND PUMPING ENGINES.	
Barr Pumping Engine Co.	xxii
Holly M'f'g Co.	xxi
National Meter Co.	iii
PUMP VALVES.	
Jenkins Bros.	back cover
TAPPING MACHINES.	
The A. P. Smith M'f'g Co.	viii
Sumner & Goodwin Co.	facing 2d cover
Walworth M'f'g Co.	ix
TOOLS AND SUPPLIES.	
Boston Engineers' Supply Co.	xxv
Eagle Oil and Supply Co.	xxiii
Perrin, Seamans & Co.	xxiv
The A. P. Smith M'f'g Co.	viii
Thos. Watkins	x

THE "AA" EMPIRE WATER METER

IS RECEIVING THE HIGHEST COMMENDATION IN ALL SECTIONS OF THE COUNTRY

Have You Given It a Trial?

300,000

CROWN—EMPIRE—NASH—GEM

METERS IN USE

NATIONAL METER COMPANY,

84 AND 86 CHAMBERS STREET, NEW YORK.

318 DEARBORN STREET, CHICAGO. 159 FRANKLIN STREET, BOSTON. SARACEN CHAMBERS, LONDON.

The Nash Gas Engine and.. Triplex Pump

..for..

Town and Village Water Works and Pumping Service Generally

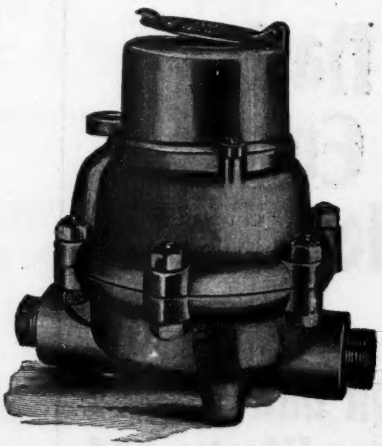
Can be adapted for either Gas or Gasolene

National Meter Company

84-86 Chambers Street

New York

Chicago	Boston	London
318 Dearborn Street	159 Franklin Street	Saracen Chambers



HERSEY DISC METER

HERSEY ROTARY METER

HERSEY TORRENT METER

The above are trade names given to the WATER METERS of our manufacture.

A full description of each type can be found in our illustrated catalog, which we would be glad to supply you if you are interested.

Over 15 years' experience in the manufacture of WATER METERS.

Over 1100 cities and towns using our meters.

HERSEY MANUFACTURING CO.

MAIN OFFICE AND WORKS, SOUTH BOSTON, MASS.

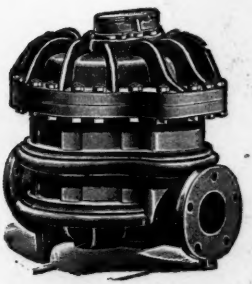
NEW ENGLAND OFFICE, TREMONT TEMPLE, BOSTON.

NEW YORK, 220 Broadway. CHICAGO, 224 Lake Street.

UNION WATER METER CO.,

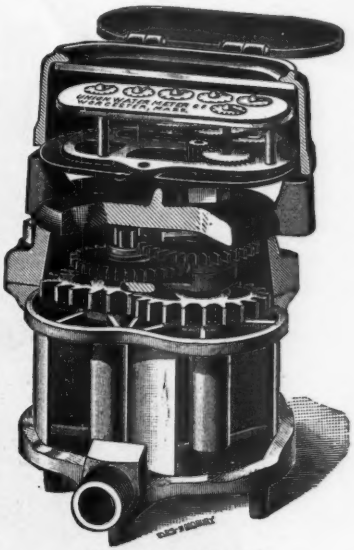
WORCESTER, MASS.

Incorporated 1868.



Extra Heavy Rotary Piston Meter.

Sectional Cut

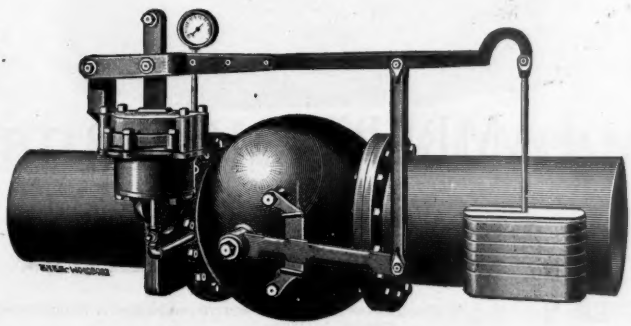


Showing 58-inch Union Rotary Piston Meter.

Manufacturers of the METER most extensively used on

HYDRAULIC ELEVATORS, LOCOMOTIVE STAND PIPES, etc., etc.

Sizes 4 inches to 16 inches.

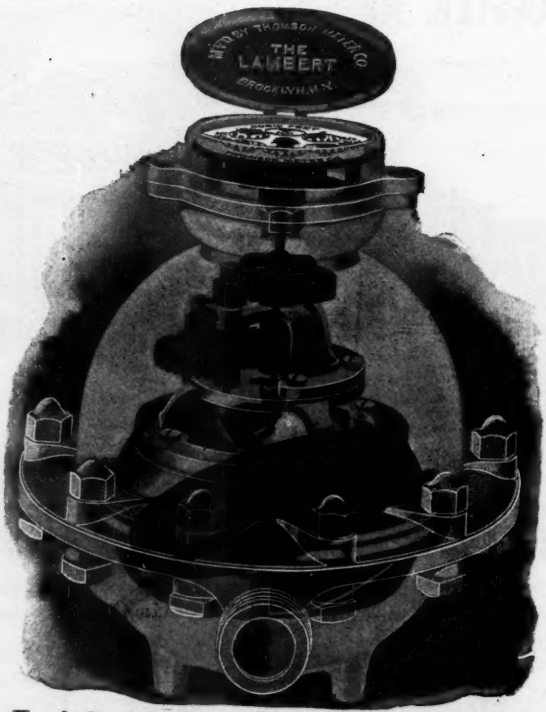


Send for Catalogue, etc.

Water Pressure Regulator.

The only positive Automatic Water Pressure Regulator in the market. We have never had a failure.

S. D. M. J.



LAMBERT METER

METER No. 50,000	STAMPED AND SHIPPED TO COUNCIL BLUFFS, IOWA, MARCH 31, 1894.
METER No. 100,000	STAMPED AND SHIPPED TO PROVIDENCE, RHODE ISLAND, AUGUST 24, 1897.
METER No. 150,000	STAMPED AND SHIPPED TO WOONSOCKET, R. I., DECEMBER 28, 1899.
METER No. 192,812	SOLD SEPTEMBER 1, 1901.

The Trident Water Meter

SOME OF ITS ADVANTAGES:

The only meter in which the disk makes no contact against the diaphragm. Therefore, ***cannot be broken by fast running.*** The practical result is: Where ***others smash*** the Trident stands.

The Compound Spur Gear train is ***indestructible*** in regular service. Yet it is quite as sensitive as the archaic types of meter trains.

If frozen, the damage, in the $\frac{5}{8}$, $\frac{3}{4}$, and 1 inch sizes, when provided with the resilient frost-bottom, will be ***nothing.*** We insure all damage from freezing whatsoever. How does this compare with the cost of insulating against frost?

Its performance has been ***highest*** in the comparative tests made by superintendents of water-works departments. Results of many of these trials may be had for the asking.

Its Maintenance Account is ***many times less*** than that of any other meter of any type, or style, or name. We are prepared to "back" this proposition for glory, for science, or for cash. Free for all; fair field and no favor.

NEPTUNE METER COMPANY,

MAKERS OF

THE TRIDENT WATER METER,

Designed by JOHN THOMSON, M. Am. Soc. C. E.

FACTORY and MAIN OFFICE: Jackson Avenue and Crane Street, Long Island City,
Telephone, 10 Greenpoint.

NEW YORK CITY OFFICE: 253 BROADWAY,
Long Distance Telephone, 3080 Cortlandt.

Distributing Warehouses:

409 Commercial Street, BOSTON. 92 La Salle Street, CHICAGO.

AUGUST, 1901.

S. D. M. J.

THE

A. P. SMITH MANUFACTURING CO.

NEWARK, N. J.

Manufacturers of

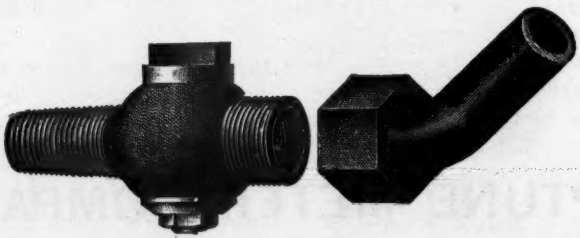
Tapping Machines, Fire Hydrants,
Water Gates, Economic Lead Furnaces,
Corporation and Curb Cocks,
Brass and Aluminum Castings.

Also General Supplies for Water and Gas Works.

Write for Catalogue.

M. J. S. D.

THE PECK BROS. & CO.



Manufacturers ...of... **Brass Goods** of every Description

FOR WATER, GAS, AND STEAM.

WE MAKE A SPECIALTY OF TESTED AND FIRST-CLASS GOODS IN BRASS FOR WATER COMPANIES.

Factory and General Office, NEW HAVEN, CONN.

27 West 42d Street and 30 West 43d Street, NEW YORK.

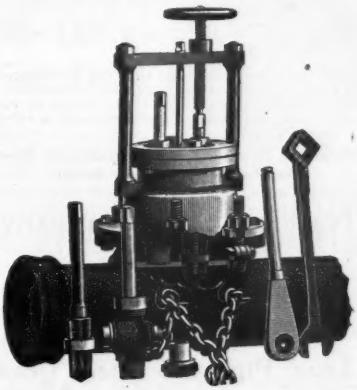
155 and 157 High Street, BOSTON, MASS.

D. M. J. S.

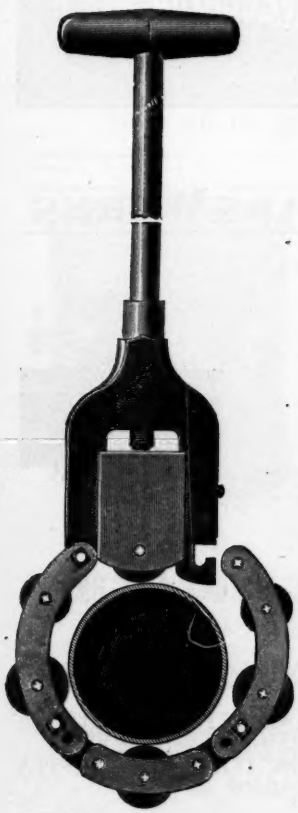
WALWORTH M'F'G CO.

BOSTON,

NEW YORK OFFICE,
PARK ROW BUILDING,



Manufacture and control



THE HALL TAPPING MACHINE

Without an equal.
Three machines in one.
Endorsed by all who have used it.

Also,

THE HALL PATENT PIPE CUTTER

For Cutting Cast Iron Pipe in the Trench.

Wrought and Cast Iron Pipe and Fittings.
Brass Work of all Kinds.
Water, Steam, and Gas Fitters' Tools and Supplies.
Extension Shut-off Boxes.
Straight-way and Hydrant Valves a Specialty.
Miller's Ratchet Pipe-Cutting and Threading Tools, &c.

B. D. M. J.

DAVIS & FARNUM M'F'G CO.

Engineers, Founders & Machinists,

MANUFACTURERS OF

Cast Iron Gas and Water Pipe and Specials; Flange Pipe, Street Castings, Iron Columns, Gas Holders, Sugar-House Work, Iron Roofs and Floors, and every apparatus pertaining to a complete Gas Plant.

Principal Office and Works, Waltham, Mass.
Boston Office, 8 Oliver Street.

National Lead Company.

BOSTON BRANCH:

89 State Street, Boston, Mass.

MANUFACTURERS OF

Lead Pipe and Sheet Lead.

PIPE JOINTERS.

The Standard. . . . . The Best.

WATKINS PIPE JOINTER.

THOS. WATKINS,
Johnstown, Pa.

JAS. B. CLOW & SONS, Chicago . . Agents.

J. S. D. M.

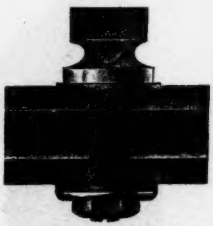
J. B. CAMPBELL BRASS WORKS.

16th STREET, ERIE, PA.

CORPORATION COCKS,

CURB COCKS,

SERVICE BOXES,



.. AND ..

ALL GOODS FOR WATER AND GAS CONNECTIONS.

J. S. D. M.

WRITE FOR CATALOGUE,
AND LET US QUOTE
ON YOUR NEXT SUPPLY.

They set the Pace

ASHTON POP VALVES and... STEAM GAGES

Superior in Quality of material and workmanship, and with greatest efficiency and durability, they challenge comparison with any others on the market. Send a trial order subject to approval ONLY IF SATISFACTORY, and thereby prove the claims made for them. HIGH GRADE GOODS OUR EXCLUSIVE SPECIALTY.

The ASHTON VALVE CO., 271 Franklin Street, BOSTON, MASS.

J. S. D. M.

SCANNELL & WHOLEY

Manufacturers of

STEAM BOILERS

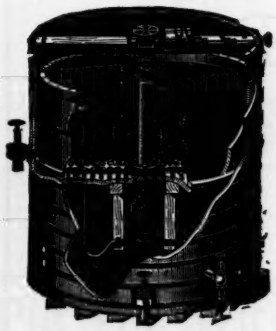
Stand Pipes, Penstocks, Tanks, Etc.

STEEL and IRON PLATE WORK

OF EVERY DESCRIPTION

Nos. 26 to 48 Tanner St., Lowell, Mass.

S. D. M. J.



GRAVITY AND PRESSURE FILTERS

Constructed under the

JEWELL, WARREN AND HYATT PATENTS.

"The Acknowledged Standard of Mechanical Filtration."

Adopted by 152 cities.

Patents Sustained by the Highest Courts. Highest Efficiency. Lowest Prices.

NEW YORK CONTINENTAL JEWELL FILTRATION CO.

15 BROAD STREET, NEW YORK.

. D. M. J.

WE have manufactured *LEAD LINED IRON PIPE* for ten years. If you want a reliable Service pipe, you should use it. We also manufacture *Tin Lined Iron Pipe.*

Lead Lined Iron Pipe Co.

WAKEFIELD
MASS.

THOS. E. DWYER
Manager

Chadwick-Boston Lead Co.

Corner Congress and Franklin Streets

162 Congress St. **BOSTON** **180 & 182 Franklin St.**

LEAD PIPE AND SHEET LEAD

Patent Tin-lined Pipe

Pure Block Tin Pipe

PIG LEAD

(Best Brands for Joint Work always in Stock)

Pig Tin, Wire Solder, Pumps, etc.

ALSO

"Forest River" and "Star" Brands

PURE WHITE LEAD

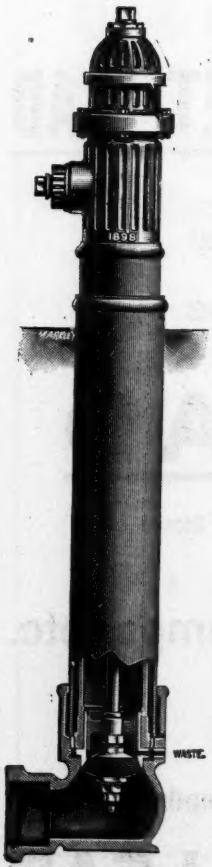
S. D. M. J.

R. D. WOOD & CO.

Constructors of Water and Gas Works

Engineers Iron Founders and Machinists

Office .... 400 Chestnut Street, Philadelphia.



"Improved" Hydrant. 4½, 5, and 6 inches. Valve-opening.

M. J. S. D.

Foundries and Works:

MILLVILLE,
FLORENCE,
CAMDEN,
NEW JERSEY.

Manufacturers ....of

CAST IRON PIPE

TURBINE WHEELS,

Pumping Machinery,

Hydraulic Cranes,

Lifts and Machinery,

Heavy Loam Castings,

Gate Valves,

"Mathews'" Hydrants.

ALL SIZES of CAST IRON PIPE

For WATER and GAS COMPANIES.

Special Attention Paid to

Railroad and Turnpike Culverts.

Flange Pipe and Flange Fittings.

HEAVY CASTINGS and those made from ORIGINAL DESIGNS.

SEND FOR CIRCULAR AND PRICES,

United States Cast Iron Pipe and Foundry Company,

638 "THE ROOKERY," CHICAGO, ILLINOIS.

THE FOLLOWING PLANTS HAVE BEEN PURCHASED AND ARE NOW OPERATED BY THIS COMPANY:

Addyston Pipe and Steel Company, Cincinnati, O. (With foundries at Addyston, O., and Newport, Ky.)
The Ohio Pipe Company, Columbus, O.
Lake Shore Foundry, Cleveland, O.
Dennis Long & Company, Louisville, Ky.
Buffalo Cast Iron Pipe Company, Buffalo, N. Y.
National Foundry and Pipe Works, Scottdale, Pa. (Limited.)
McNeal Pipe and Foundry Company, Burlington, N. J.
Wisconsin Steel Company, West Superior, Wis.
American Pipe and Foundry Company, Chattanooga, Tenn. (With foundries at Bessemer, Ala.; Anniston, Ala.; Bridgeport, Ala.; Chattanooga, Tenn.; and South Pittsburg, Tenn.)

Warren Foundry and Machine Co.

ESTABLISHED 1856.

Works at Phillipsburg, New Jersey. .....

Sales Office, 160 Broadway, New York.

Cast Iron, Water and Gas **PIPE** From 3 to 48 inches in diameter.

—ALSO—

ALL SIZES OF FLANGED PIPE

S. D. M. J. AND SPECIAL CASTINGS.

EMAUS PIPE FOUNDRY, DONALDSON IRON CO.,

MANUFACTURERS
...OF...

CAST IRON PIPE

...AND ..

Special Castings for Water and Gas.
Also Flange Pipe, Lamp Posts, Street Castings,
Manhole Heads and Covers, etc.

JOHN DONALDSON, President,
Betz Building, Philadelphia, Pa.
GEORGE ORMROD,
Manager and Treasurer, Emaus, Pa.

S. D. M. J.

EMAUS,
LEHIGH COUNTY, PA.

Globe Special Castings

What People Say of Them:

"I prefer your Globe Specials to any we have ever used."

"I think they are the most practical specials in use at the present time."

"No special made to-day compares with the Globe Special as to convenience in handling."

"They are certainly a saving to the party who furnishes the pipe."

BUILDERS IRON FOUNDRY

PROVIDENCE, R. I.

Genuine EDDY VALVES are made by us only,

AND FULLY GUARANTEED.

SPECIFY AND INSIST ON THE EDDY,

TO GET THE BEST.

Eddy Fire Hydrants combine all the good features of other makes, and many very desirable ones besides, making them ***the Standard of Excellence.***

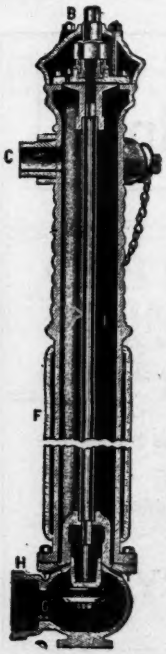
WE ALSO MANUFACTURE CHECK, FOOT AND AIR VALVES, SLUICE GATES, INDICATOR POSTS, WATER CRANES, FLUSH HYDRANTS, Etc., Etc.

... Send for Catalogue or Special Circulars.

EDDY VALVE CO.,

WATERFORD, N. Y., U. S. A.

S. D. M. J.



THE VALVES
AND HYDRANTS

Manufactured by the

KENNEDY VALVE MFG. CO.

ARE

SIMPLE
SURE
SAFE
SUPERIOR

AND ARE APPROVED BY

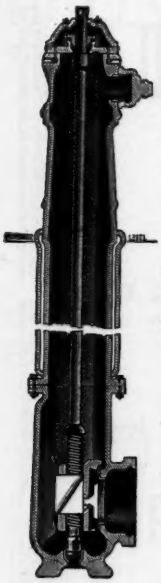
EMINENT
ENGINEERS

Prices and particulars on application to their office at

57 Beekman St., New York

WORKS: Coxsackie, N. Y.

J. S. D. M.



THE LUDLOW VALVE MFG. CO.

...MANUFACTURERS OF...

VALVES AND FIRE HYDRANTS

This hydrant is anti-freezing, because when the drainage is good no water is left in it to freeze. The drip is directly in the bottom of the hydrant and drains perfectly. It is protected by its valve, which never leaves its socket and cannot be clogged.

DOUBLE AND SINGLE GATE VALVES,
ALSO CHECK VALVES,
FOOT VALVES.

FIRE HYDRANTS.

YARD, WASH, AND FLUSH HYDRANTS.

SEND FOR CIRCULARS.

OFFICE AND WORKS: FOOT OF ADAMS STREET, TROY, N. Y.

S. D. M. J.

COFFIN VALVE CO.

Neponset, Boston, Mass.

Fire Hydrants

Valve opens down
Valve has rubber face
Valve cannot chafe
No water hammer
Buckling rods avoided
Valve removed without digging
Least loss by friction
Best waste device

ASK FOR DESCRIPTION

Rensselaer Mfg. Co.

TROY, N. Y.

MANUFACTURERS OF

BRASS AND IRON

GATE VALVES

For Water, Gas, Steam or Oil.

ALSO THE IMPROVED PATENTED BALANCE SWING-GATE CHECK VALVES.

THE COREY FIRE HYDRANT

CHICAGO OFFICE, 1108-9 MONADNOCK BLOCK.

S. D. M. J.

Artesian and Driven Wells.

WE have had over twenty-four years' experience in supplying cities, towns, and large corporations by the Artesian and Driven Well system. Also driven many thousand wells for domestic purposes.

Sand and Vacuum Chambers.

HORIZONTAL.

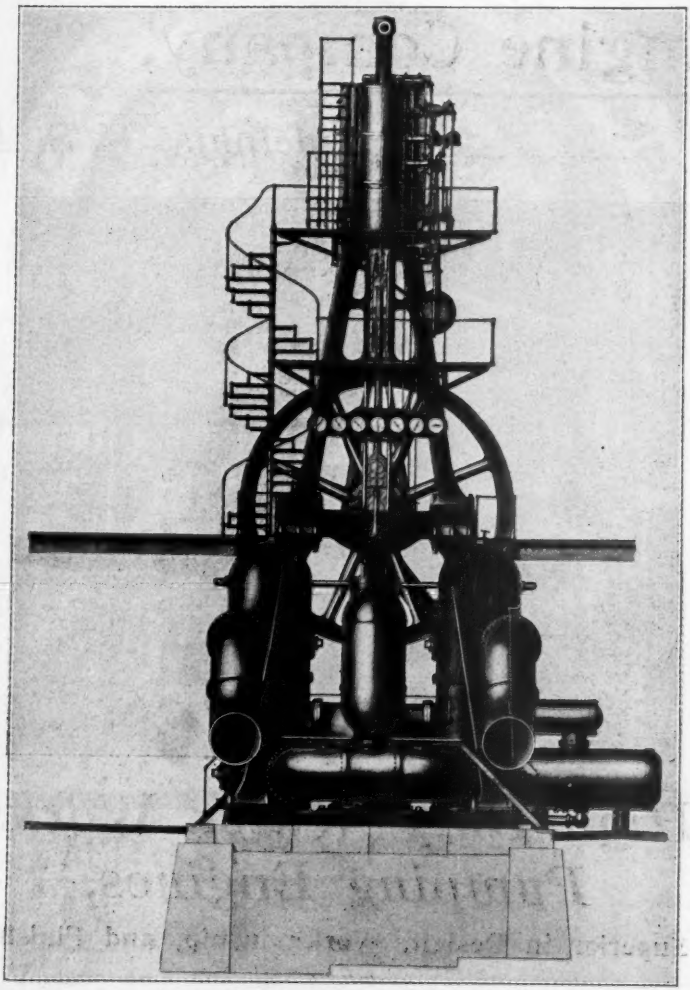
We have patented and manufacture sand chambers. Smaller sizes fitted for 1½-in. to 6-in. pipes, made of heavy hammered copper, guaranteed not to leak or collapse. Larger chambers for water works where from 500,000 to 6,000,000 gallons of water are pumped, made of wrought-iron, fitted with 8-in. to 20-in. pipe. All chambers are warranted to stop sand, or money refunded, if we know the quantity of water to be pumped and the quality of sand. Call on or address,

B. F. SMITH & BRO., 38 Oliver Street, Boston.

J. S. D. M.

HOLLY MANUFACTURING CO.

LOCKPORT, N. Y.



Holly High Duty Pumping Engine, No. 9. Spot Pond Pumping Station, Metropolitan Water Works, Boston, Mass. Daily Capacity, 20,000,000 gallons. Duty (official test), 177,961,000 foot-pounds per 100 pounds dry coal.

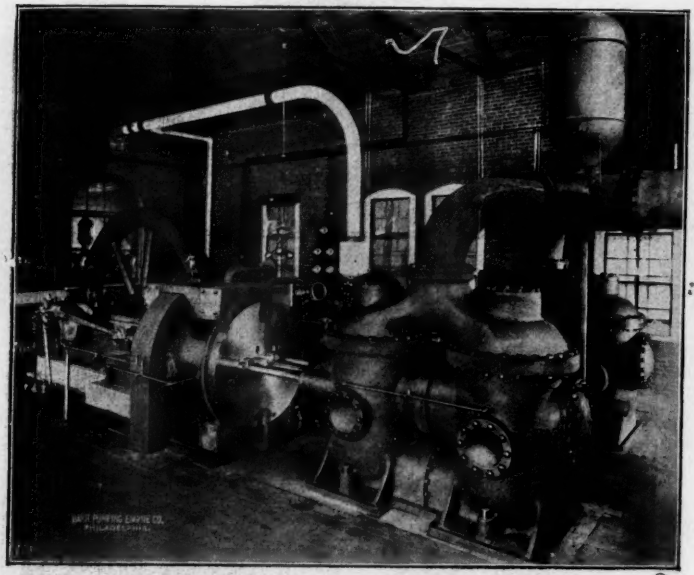
HIGH DUTY PUMPING ENGINES

120 Liberty Street - - - NEW YORK

J. S. D. M.

Barr Pumping Engine Company,

Philadelphia, U. S. A.



High Duty Water Works Pumping Engines,

Superior in Design, Workmanship, and Finish.

PUMPS OF ALL DESCRIPTIONS.

Boston Office and Salesroom: 151 Congress Street.

W. H. BODFISH.

Telephone 2577-2.

M. J. S. D.

Don't think so much what OIL is going to cost; think more about what it is going to do.

SOLE MANUFACTURERS OF

EAGLEINE HIGH PRESSURE CYLINDER OIL

We manufacture an Oil especially adapted for pumping machinery, and in all cases it has given excellent results. Many members of this Association have been customers of ours for years, and speak in the highest terms of our Eagleine Cylinder Oil, and the results obtained by its use have been very satisfactory. We solicit a trial order, and will send a sample barrel on thirty or sixty days' trial.

NEW ENGLAND AGENTS FOR

SOLARINE METAL POLISH

For Brass, Steel, and Nickel-plate

FREE SAMPLE

IMPORTANT...

In connection with our Oil and Grease Departments we have a

SUPPLY DEPARTMENT

This we wish to call your special attention to for the following reasons: First, we carry a stock of supplies used in Pumping Stations second to none in our city; Second, we guarantee to deliver exactly what we represent, and will stand all expenses if we do not; Third, we can deliver goods promptly, and our prices are low for what we deliver; Fourth, by having such an extensive supply department to order from it enables you to keep your Oil, Grease, and Supply account under one head. REMEMBER that we keep everything in supplies, and everything in our place in its place. We invite inspection. Catalogues of our numerous specialties sent free.

"With EAGLEINE OILS and SOLARINE METAL POLISH
We Lubricate and Shine where others fail"

PERRIN, SEAMANS & CO.

57 OLIVER STREET, BOSTON, MASS.

TOOLS AND SUPPLIES

FOR

WATER WORKS CONSTRUCTION

Send for Catalogue No. 6.

S. D. M. J.

Members of the Association AND
Subscribers to the Journal

Can help pay the cost of publication by consulting the advertisements when in need of supplies.

ESTABLISHED 1853.

14,000,000 BARRELS

"HOFFMAN"

....CEMENT....

Have been used on important works throughout the United States.

NO OTHER CEMENT COMPANY CAN SHOW SUCH A RECORD.

LAWRENCE CEMENT CO.

ERNEST E. ACKERMAN (Assoc. Am. Soc. C. E.), President.

Sales Office, No. 1 Broadway, New York.

S. D. M. J.

E. P. McDONOUGH. HENRY M. CLARK.

Boston Engineers' Supply Co.,

RUBBER HOSE, BELTING AND PACKING,

Oils and Mill Supplies,

ENGINE PACKINGS, GREASE AND SPECIALTIES,

No. 143 Broad Street,

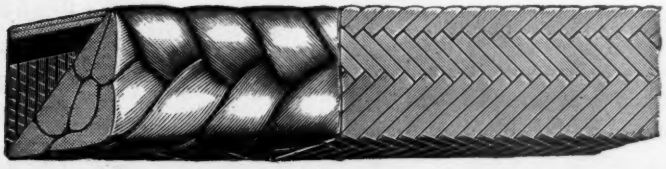
TELEPHONE, BOSTON 3559-2. **BOSTON.**

Handlers of "Highest Grades Cylinder Oils."

M. J. S. D.

"Combination"

HYDRAULIC AND STEAM PACKING



PATENT APPLIED FOR.

An Elastic Sectional Rod and Plunger Packing.

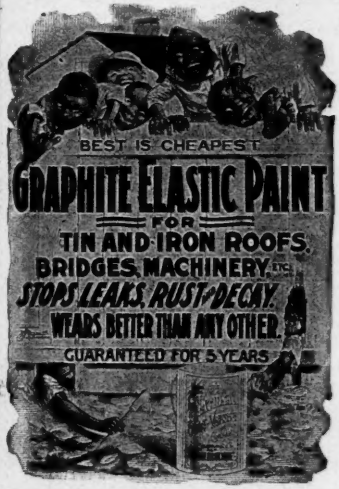
A. W. CHESTERTON & CO.,

64 India Street, Boston.

M. J. S. D.

MEMBERS of the New England Water Works Association, when about to purchase supplies, should always consult the advertising pages of the JOURNAL, and at least allow the advertisers a chance to submit prices. When writing to advertisers always mention this JOURNAL.

Water is not Tainted by this Paint



OFFICE OF
HARRY P. HUMBERT,
CITY CLERK.

KEITHSBURG, ILL.,
October 23rd, 1899.

The National Paint and Varnish Company,
Manufacturers of Graphite Paints and Varnishes,
Cleveland, Ohio.

GENTLEMEN:

Your letter of the 8th is at hand, acknowledging receipt of the money sent you in payment for the paint purchased of your agent, that we painted our Stand Pipe with. Will say that we painted the stand pipe inside and out with your paint. So far it has given very excellent satisfaction. It has the body, together with the staying qualities, and to any one needing a paint for iron or steel, must say that they could not do better than to purchase your paint. In conclusion, will say that we have not had one complaint from the water being tainted by the paint since the water was turned on after finishing the painting, and we did not give it much time after the paint was put on. Hoping that you will have good success with your paints, as you deserve it, we remain,

Yours truly,
Approved: TOM A. MARSHALL,
Mayor.
Attest:
HARRY P. HUMBERT,
City Clerk, and Supt. Water Works.

S. D. M. J.

THE GOULD PACKING CO.

Gould's Packing

Trade Mark.

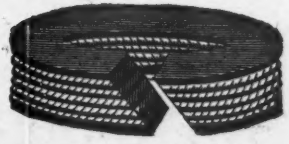
If you want the best, get

Gould's Steam and Water Packing ....

The original ring packing

Buyers will see that our name, Gould's Steam and Water Packing, and our Trade Mark are stamped on every package. *Unless so stamped they are imitations.*

In ordering be careful to give the EXACT diameter of stuffing-box and of piston-rod or valve-stem.



88 Cambridge Street, East Cambridge, Mass.

S. D. M. J.

VENTURI METER

The VENTURI METER is a practical meter for measuring large quantities of water.

ITS ACCURACY is unquestioned, and it is frequently employed to test the performance of pumps.

NO BY-PASS is necessary, and the cost of tees, elbows, and gate valves is avoided.

BUILDERS IRON FOUNDRY,
Providence, R.I.

.D M. J. S.

Packings that Pack

HIGH PRESSURE

WATERPROOF HYDRAULIC

GARLOCK HIGH PRESSURE RING is made especially for high steam pressures. The rubber cushion is on the **INSIDE**, and can't be damaged by oil or intense heat — the fibrous matter is absolutely **HEAT PROOF**. It positively cannot bake, vulcanize or "burn out"; it must **WEAR** out. It gives from four to six times the service of any other fibrous steam packing.

WE GUARANTEE THAT IT WILL EASILY OUTWEAR ALL OTHERS, OR WILL COST YOU NOTHING

GARLOCK WATERPROOF HYDRAULIC is positively without an equal for cold water. It is used by the U. S. Government on the disappearing gun carriages of all coast fortifications, and against hydraulic pressures of from 1000 to 2500 pounds per square inch. Used by City of New York, Boston, Lowell, Lawrence, and most of the large pumping stations in this country. It will easily outwear any others on cold-water plungers and rods.

OUR OFFER is to make you up a set of either of these, and if not the best you've ever used, we won't charge you a cent. You can be the judge.

CAN'T YOU GIVE US A TRIAL?

THE GARLOCK PACKING CO.

All kinds of Packings and Engineers' Supplies

12 Pearl Street . . . . Boston

New York San Francisco Chicago Philadelphia Denver St. Louis Pittsburgh Cleveland
Palmyra, N. Y. Rome, Ga.

I. S. D. M.